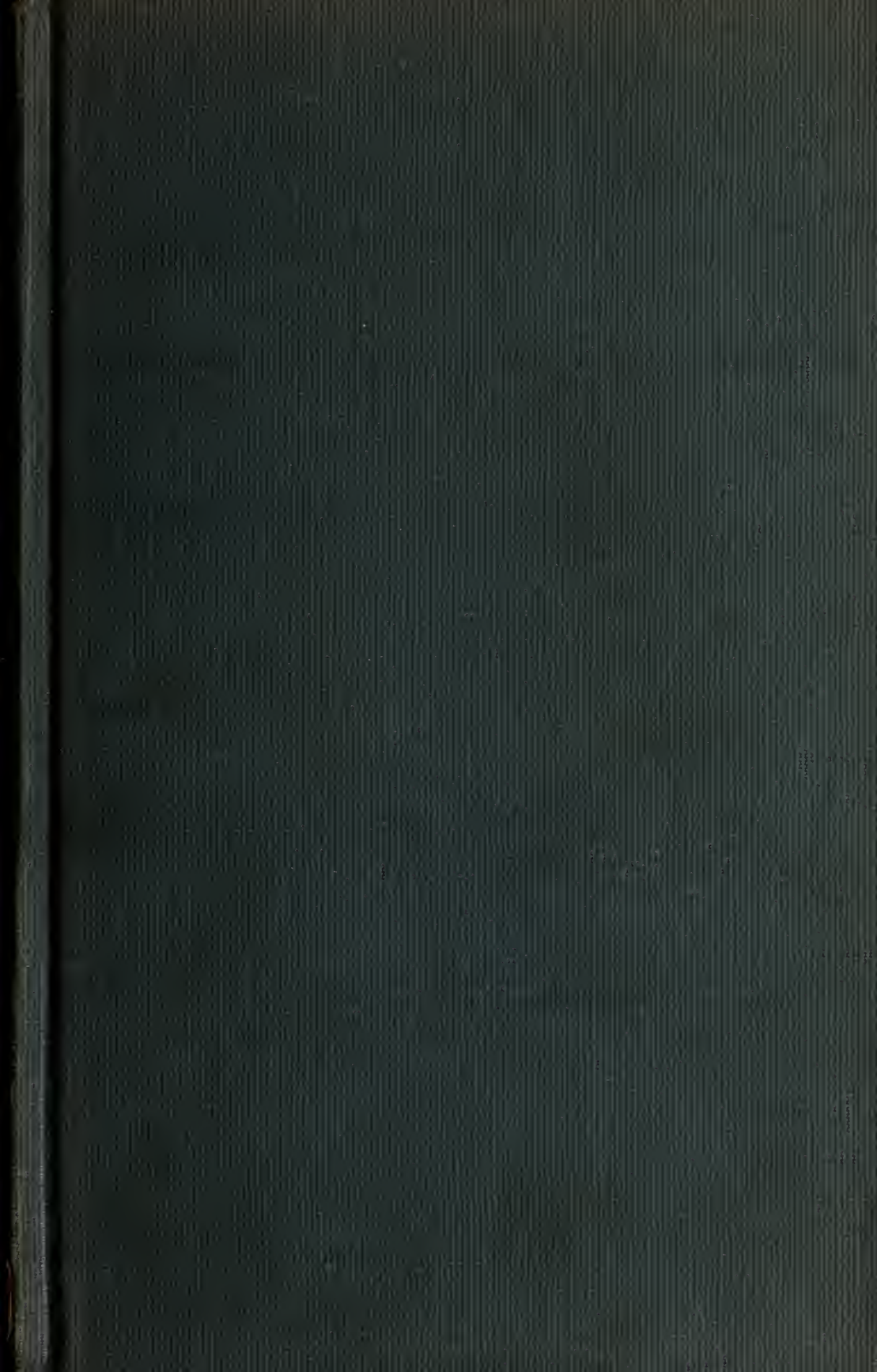




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UNITED STATES DEPARTMENT OF LABOR
FRANCES PERKINS, Secretary
CHILDREN'S BUREAU . . KATHARINE F. LENROOT, Chief

Occupational Hazards to Young Workers

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REPORT NO. 3

THE COAL-MINING INDUSTRY



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OCCUPATIONAL HAZARDS TO YOUNG WORKERS

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Report No. 2.—Motor-Vehicle Drivers and Helpers, Publication No. 274.

Report No. 3.—The Coal-Mining Industry, Publication No. 275.

Report No. 4.—The Logging and Sawmilling Industries, Publication No. 276.

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LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR,
CHILDREN'S BUREAU,
Washington, October 10, 1941.

MADAM: There is transmitted herewith a report on the occupational hazards to young workers of employment in the coal-mining industry. This investigation is the third of a series conducted by the Children's Bureau to guide the Chief of the Bureau in determining occupations that are particularly hazardous for young workers and therefore subject to an 18-year minimum-age standard under the Fair Labor Standards Act of 1938. The report was originally published in mimeographed form on June 7, 1940, when a proposed order was issued for coal-mining occupations. This order, known as Hazardous-Occupations Order No. 3, became effective on September 1, 1940. It declares all work underground in coal mines and most surface occupations about such mines to be particularly hazardous for workers 16 and 17 years of age. A copy of the order is included in the appendix to this report.

The discussion of the hazards of coal-mine occupations and the industrial-injury data presented should be of general interest to coal-mine operators, representatives of organized labor, safety engineers, officials of State departments of labor and industrial-accident commissions, and other persons interested in promoting safe working conditions in the coal-mining industry. The statistics and other information in this bulletin are those which appeared in the mimeographed report, without the addition of figures that have become available since the original date of publication.

The Children's Bureau wishes to acknowledge with appreciation the assistance which the Bureau received during the preparation of this report from the following persons, who reviewed the draft and made valuable suggestions regarding its content and conclusions on the basis of their knowledge of the industry:

C. E. Berner, Superintendent, Coal Mine Section, Pennsylvania Compensation Rating and Inspection Bureau, Harrisburg.

Harvey Cartwright, Commissioner, Indiana Coal Operators Association, Terre Haute, Ind., representing the National Coal Association, Washington.

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Joe Ozanic, President, Progressive Mine Workers of America, Springfield, Ill.
N. P. Rhinehart, Chief, Department of Mines, Charleston, W. Va.

The study was planned and carried on under the general direction of Beatrice McConnell, Director of the Industrial Division of the Bureau, and Elizabeth S. Johnson, assistant director in charge of research. Sheldon W. Homan, safety engineer, conducted the field work and was responsible for the technical aspects of the report. Miriam Noll, specialist in accident statistics, developed the statistical material on industrial injuries. The report was written by Helen Wood, associate in hazardous-occupations research.

Respectfully submitted.

KATHARINE F. LENROOT, *Chief.*

HON. FRANCES PERKINS,
Secretary of Labor.

Occupational Hazards to Young Workers

The Coal-Mining Industry

Under the Fair Labor Standards Act of 1938 the Chief of the Children's Bureau is given the responsibility of determining occupations that are particularly hazardous for young persons 16 and 17 years of age and therefore subject to the 18-year minimum-age provision of the act. The present investigation of the hazards of coal-mine occupations was undertaken with a view to determining whether any or all of these occupations should be declared particularly hazardous for persons 16 and 17 years of age. It was made in accordance with regulations of the Children's Bureau governing the procedure to be followed in making such determinations.¹

The coal-mining industry was selected for study because it is known as one of the most hazardous industries in the country and because it employed a considerable number of boys under 18 years of age at the time of the 1930 census. The recurrent coal-mine disasters which take many lives at one time have dramatized the hazards of the industry and attracted widespread public attention, but a much larger number of workers are killed or injured annually in the many accidents involving only one or a few coal-mine employees than are killed or injured in the more spectacular and publicized disasters. Among the industries of the country for which adequate and comparable statistical information is available, coal mining ranks first in the frequency with which fatal injuries occur to its workers and second in the frequency of all disabling injuries, fatal and nonfatal combined.²

¹ Appendix A, p. 47, presents the legal basis of this investigation.

² The statistics and other information in this bulletin are those which appeared in the mimeographed report, without the addition of figures that have become available since the original date of publication.

METHOD AND SCOPE OF STUDY

The information presented in this report was obtained through analysis of published and unpublished data regarding the coal-mining industry and its workers, through investigations of the operations of a number of coal mines of various types, and through conferences with many persons having expert knowledge of the industry and its hazards. Statistics on coal-mine production and employment, accident statistics compiled by a number of governmental and private agencies, and laws, regulations, and union agreements establishing minimum-age standards for coal-mine employment have been analyzed. A number of anthracite mines in Pennsylvania and a larger number of bituminous mines in several States were visited for the purpose of obtaining detailed information with regard to the nature and the hazards of the different coal-mine occupations.

The many persons with expert knowledge of the industry who were consulted included representatives of labor organizations and of trade associations, mining engineers, mine inspectors and other Government officials, experts in the fields of safety and coal-mine technology, and other interested persons. On the basis of their specialized knowledge and experience, these persons provided information regarding the hazards involved in coal-mine employment and the customary minimum-age standards for such work. They also gave their opinions regarding the hazards for minors under 18 years of age in the various coal-mine occupations and regarding the need to apply to these occupations the 18-year minimum age for hazardous employment set by the Fair Labor Standards Act.

The investigation covered the mining of all ranks of coal recognized by the United States Geological Survey, including lignite, bituminous, and anthracite. It did not cover the gathering of peat, which is commonly regarded not as a variety of coal but as a preliminary stage in its formation, and which is extracted by ploughing operations rather than by mining methods. The mining of graphite was also considered outside the scope of the investigation. This substance, though a member of the carbon family closely related in structure to anthracite, is used for entirely different purposes than coal, and its mining is generally considered a separate industry from coal mining.

Coal mines with underground workings having shaft, slope, and drift entrances have been included in this survey, as have also open-cut mines. The only method of recovering coal excluded from the field of investigation was dredging from river bottoms, which is done in some localities to recover coal washed down from mines upstream. This process is more closely related in nature and hazards to other dredging operations than to coal mining.

The occupations with which the investigation is concerned include not only all work underground in coal mines but also all surface occupations about mines which contribute directly or indirectly to

the extracting, grading, cleaning, and handling of the coal up to and including its loading at the shipping point. However, the study did not cover work about coke ovens or other processing or byproducts plants; nor did it cover work in company stores, the construction or maintenance of housing or other facilities for the use of mine employees and their families, or other occupations not concerned with the actual production of coal, even though the work was done on property owned by the mine operator and performed by persons in the mine operator's employ. It should be noted also that the investigation did not extend to the hazards involved in the operation of particular types of metal- and woodworking machines, used in repair and maintenance work, which are similar to those used in other industries.

CHARACTERISTICS OF THE INDUSTRY.

Types of Coal and Location of Coal Fields

Within the boundaries of the United States, there are all ranks of coal, from coarse, woody, brown lignite to the highest rank of anthracite. The change from lignite, which is geologically the youngest type of coal, to anthracite, the oldest and most metamorphosed type, is progressive and gradual. The United States Geological Survey recognizes the following ranks of coal, on the basis of a number of criteria, part physical and part chemical: (1) lignite, (2) subbituminous,¹ (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite.² Included within these ranks are coals of many special types—such as cannel, coking, gas, block, and splint—having distinctive characteristics which affect the commercial utilization of the coal but do not have any significant relation to mining hazards.

There are coal deposits in a large majority of the 48 States, though many of these deposits have been little used as yet. In some fields where the expenses of operation are high or the coal is inferior in quality, coal is mined in some years but not in others, with the result that the group of States producing coal varies over a period of time. For the purpose of this investigation, the 24 States³ in which coal is regularly mined in considerable amounts for commercial use are considered as coal-producing.⁴

Almost all the anthracite mined in the United States comes from a small area in eastern Pennsylvania. Semianthracite, which is a hard coal though not so hard as true anthracite, is mined in one county in Pennsylvania and in various small fields elsewhere, but nowhere in large amounts. Soft coal constitutes the bulk of the country's coal output, bituminous coal of some rank being mined in 22 of the 24 coal-producing States and only lignite in the other 2 States (North Dakota and South Dakota).

Despite the diversity of coal deposits in the United States and their wide geographic distribution, the coal-mining industry of the country is customarily separated into two divisions, which have the sanction of trade practice and historical usage. These are the Pennsylvania anthracite industry (which includes all the hard coal mined in Pennsylvania, semianthracite as well as anthracite) and the bituminous-coal

¹ Subbituminous coal has frequently been called black lignite, but the Geological Survey sometime ago discarded this term as unsuitable, since subbituminous coal is lignitic neither in texture nor in appearance.

² The Coal Fields of the United States, Professional Paper 100-A, pp. 3-8. U. S. Geological Survey, Washington, 1922.

³ Alabama, Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, Wyoming. Each of these States produced at least 400,000 tons of coal during 1938.

⁴ Coal is also mined regularly in four other States (Georgia, Idaho, Oregon, and South Dakota), no one of which produced as much as 50,000 tons during 1938. In addition, five States (Arizona, California, Nebraska, Nevada, and North Carolina) produce small quantities of coal in some years and none at all in others.

industry (which comprises the country's entire production of soft coal and with which are included, for statistical purposes, the relatively small amounts of hard coal mined outside Pennsylvania). This system of classification will be followed throughout this report in presenting statistics with regard to coal-mine production, employment, and accidents.

Production and Employment in the Industry

The importance of the coal-mining industry to the economic life of the country is indicated by the fact that during 1938 this industry is estimated to have produced 390,729,000 tons of coal and to have employed during periods of active operation about 532,000 workers. The Pennsylvania anthracite industry produced 46,099,000 tons of coal and employed 97,000 men;⁵ the bituminous-coal industry produced 344,630,000 tons and employed 435,000 men.⁶ These figures are exclusive of the output and working force of many small unauthorized anthracite mines (the so-called bootleg mines of Pennsylvania) and of bituminous mines producing less than 1,000 tons a year, for which no comparable figures on production and employment are available. The omission of the bootleg anthracite mines from these figures is a matter of some importance since, according to estimates of the Pennsylvania Department of Mines, these mines produced about 2,500,000 tons of coal in 1938, or 5 percent of the total output of anthracite from both authorized and unauthorized mines.⁷ On the other hand, the omission of bituminous mines with an annual production of less than 1,000 tons makes no appreciable difference in the tonnage figures and very little difference in the figures on employment.

The 1938 tonnage figures represent, in comparison with those for several previous years, a sharp decline in the production of coal. In 1938 anthracite production and employment were actually below the low point reached in 1933 at the depth of the depression, although bituminous production and employment remained a little above that level.⁸

The bulk of the country's coal output comes from a small group of States, the relative standing of which has varied little during the last few years, despite the fluctuations in the country's total output of coal. The anthracite industry, as defined in trade practice and in this report of investigation, is, of course, restricted to Pennsylvania. In the bituminous industry, Pennsylvania and West Virginia together produced 52 percent of the total output of coal and afforded employment to 50 percent of the workers during 1937. Altogether, 4 States produced 74 percent and 11 States 93 percent of the 1937 bituminous output, the corresponding figures for employment being very similar. (Appendix B, table I, p. 48.)

Since the production of coal is concentrated in a few States while its market is Nation-wide, a large proportion of the country's coal output moves in interstate commerce. Approximately two-thirds of the tonnage produced by the Pennsylvania anthracite industry is shipped out

⁵ Minerals Yearbook, 1939, p. 833. Bureau of Mines, U. S. Department of the Interior, Washington.

⁶ Ibid., p. 770.

⁷ Ibid., p. 831.

⁸ Ibid., pp. 770, 833; and Minerals Yearbook 1935, p. 614.

of Pennsylvania.⁹ Of the total output of bituminous coal in the United States, about three-fourths moves in interstate commerce, one-fourth being sold to railroads within the jurisdiction of the Interstate Commerce Commission and one-half shipped in interstate commerce to other types of consumers.¹⁰

Employment of minors under 18 years of age.

No current statistics are available showing the number of persons under 18 years of age employed in coal mining. As is indicated later in this report, legal minimum-age standards tend in a few States to eliminate the employment of persons under 18 in coal mines and in most States to eliminate the use of children under 16 in such work. However, there are still many jurisdictions in which no minimum-age restrictions have as yet been placed on the work of 16- and 17-year-old boys in coal mines.

At the time of the 1930 census there were reported to be 15,904 coal-mine operatives under 18 years of age in the country (3 percent of the 621,661 coal-mine operatives of all ages). Of these young miners, 722 were reported as under 16 and 15,182 as 16 or 17 years of age. By far the largest group (39 percent of those under 16 and 50 percent of those 16 and 17) were in Pennsylvania, either in the anthracite or in the bituminous fields. Kentucky, West Virginia, and Pennsylvania together accounted for 70 percent of the younger and 76 percent of the older group of young miners. (Appendix B, table II, p. 48.)

Since 1930 the number of coal-mine workers under 18 years of age has undoubtedly declined to some extent. The total number of workers of all ages in the industry has dropped considerably during the intervening period, and experience in other industries indicates that the employment of young persons tends to rise or fall with that of adults. Furthermore, since 1930 some States have raised the minimum-age standards for employment in mines, thus tending further to restrict the number of young people employed in coal mining. For example, Pennsylvania, which in 1930 employed more coal-mine workers under 18 years of age than any other State, has subsequently raised the legal minimum age for many coal-mine occupations from 16 to 18 years. That minors under 18 years of age are still employed in the industry is evidenced, however, by scattered data from some States showing the age of mine workers who have been injured or killed, by the recent issuance in some localities of employment certificates for work in or about coal mines, and by the fact that in inspections of mine employment made by the Children's Bureau under the Fair Labor Standards Act of 1938 a number of minors under 18 years of age were found to be employed.

⁹ The U. S. Bureau of Mines estimates that two-thirds of the tonnage produced by the Pennsylvania anthracite industry during 1939 was shipped outside Pennsylvania and that this figure represents the approximate situation during the last 5 years.

¹⁰ The Effect of Labor Relations in the Bituminous Coal Industry Upon Interstate Commerce, pp. 4, 5. Bulletin No. 2, National Labor Relations Board, Washington, 1938. These figures are based on data for 1929, but comparisons with some data for 1937, made by the Bituminous Coal Commission, indicate that there has been no substantial change in the figures during the intervening decade.

MINING PROCESSES AND OCCUPATIONS

Types of Mines

Coal is deposited in the earth in strata, called seams, which lie between strata of slate or other rock. These seams are found at widely varying depths, in some cases outcropping at the surface of the earth and in others lying many thousands of feet below it.

There are two principal methods of recovering coal, underground mining and open-cut mining (or stripping). Underground mining, which is frequently carried to a depth of many hundred feet and in a few mines in this country to a depth of more than 2,000 feet, produces the bulk of the anthracite and bituminous coal recovered. Stripping operations have, however, been carried on in recent years to a steadily increasing extent both in anthracite and in bituminous fields where there are seams lying close to the surface. During 1937 stripping accounted for 7 percent of the total production of the bituminous industry¹ and 11 percent of the production of Pennsylvania anthracite.² In 1930, on the other hand, only 4 percent of the anthracite and of the bituminous output was produced by stripping.³

In the following discussion of mining processes and occupations, consideration will be given first to underground and second to open-cut operations and finally to the surface operations common to both types of mining.

Underground Operations

Mining methods.

The lay-out of underground mines and the mining methods used depend to a considerable extent upon whether the seams are horizontal or pitching (that is, lying at an angle from the horizontal). Most anthracite beds are steeply pitching. Bituminous seams, on the other hand, are in general fairly flat, although pitching seams are encountered in some bituminous fields, especially in the States of Alabama, Oklahoma, Utah, and Washington.

Mines may have shaft, slope, or drift entrances. Where the coal seams are horizontal, the removal of coal is done in workrooms driven horizontally into the face of the coal seam from passageways, called entries or haulageways. The usual method of mining in anthracite and other pitching seams is, however, to sink a shaft at the lowest point of the strata and to drive tunnels, called headings or gangways, horizontally from the shaft at various levels, the headings cutting across the inclined coal seams. The coal is then removed as the rooms, known also as breasts, are driven upward from the headings and is conveyed downward through chutes for loading into mine cars. Sometimes the

¹ Minerals Yearbook 1939, p. 791.

² Ibid., p. 833.

³ Coal in 1930, p. 666. U. S. Bureau of Mines, Washington, 1932.

breasts are driven downward into the seam and the coal carried upward to the headings by conveyors or scraper loaders.

As conducted at the present time, the removal of coal from the seam involves five main operations underground—undercutting or shearing the coal, drilling, shooting down the coal with explosives, loading the coal into mine cars, and hauling the coal to the surface. In addition, many other operations incidental to actual coal production must be done underground, such as driving haulageways and airways, removing rock and slate to the outside or to an unused section of the mine, laying mine railway tracks, and general mine maintenance.

In the early days of coal mining, coal was shot down without undercutting. This shooting "off of the solid" broke up the coal into an excess of fine pieces and necessitated the leaving of larger pillars because of the shattering effect on the roof. It also brought down large quantities of rock, which had to be removed from the mine or stored in unused or worked-out sections. This method of mining is considered highly dangerous and is now forbidden by law in some States.

The practice of undercutting coal to loosen it so that it can be shot down more efficiently is now almost universal. At first, the work was done manually, the miner cutting with a pick a narrow slot or kerf some 2 or 3 feet deep at the bottom of the coal seam. This is an arduous and dangerous job, since the miner has to swing his pick from a lying or kneeling position. Undercutting was one of the first mining processes to be mechanized; machines are now available which will make horizontal cuts at any level on the face of the coal seams and also vertical or inclined shearing cuts either in the middle or along the side of the room. These machines are known as mining machines and shearing machines. In 1936, 85 percent of the bituminous coal produced in underground mines in this country was undercut mechanically;⁴ on the other hand, only 5 percent of the deep-mined Pennsylvania anthracite was undercut mechanically.⁵ This difference arises from the fact that the flat seams of bituminous coal are more readily undercut mechanically than the pitching seams of anthracite.

The next task after undercutting is the drilling of shot holes for explosives. In many mines this is still done by hand, using a long steel auger. However, where a mine has been electrified, it is a simple matter to bring power to the face and to bore the holes with an electric drill. In 1936 more than one-fourth (27 percent) of the deep-mined bituminous coal came from working places where the shot holes were bored by mechanical power.⁶ No comparable information is available for the anthracite industry. Since power drills have proved their value under widely different mining conditions, their use will undoubtedly spread.

The next process is to load the drilled holes for shooting, usually with explosives classified as permissible by the United States Bureau of Mines or with black blasting powder in either granular or pellet form. In gassy mines firing is done electrically; in nongassy mines fuses are generally used.

After the coal is shot down it is loaded into mine cars for hauling to the surface. Most of this work is still done by hand shoveling,

⁴ Minerals Yearbook 1939, p. 797.

⁵ Minerals Yearbook 1938, pp. 765, 776.

⁶ Minerals Yearbook 1939, p. 803.

although a variety of loading machines adapted to different seam conditions are now available. Some of these machines are mobile, being track-mounted or equipped with caterpillar treads and moving about under their own power; others are of a scraper, conveyor, or shaker type. Scrapers are used to move coal from the working face to the mine car; they are scoop devices, pulled by a cable attached to a hoist, which drag the coal along the floor, up an incline, and into the car. Another device used to load mine cars at the face is the pit-car loader; this consists of an elevating conveyor which carries coal up into the mine cars after it has been shoveled onto the lower end of the conveyor. Conveyors are, however, oftener designed to carry the coal from the working face to a mine car in the haulageway, thus eliminating the need for tracks into each room. These conveyors may be of the belt, chain, or shaker type. They are usually hand loaded, although when the conveyor is of the shaker type it may have a duckbill attachment—that is, a flat terminal section which, by the reciprocating action of the shaker, shuffles under a pile of coal and moves it by successive jerks back to the mine car.

It is estimated that in 1936, 24 percent of the anthracite and 16 percent of the bituminous coal mined underground was loaded by machine.⁷ These figures are averages for the entire industry and therefore do not show that in some districts the great bulk of the output is now being loaded by machine while in other districts mechanical loaders are almost unknown. It is expected that mechanization of loading will spread rapidly in these latter districts, especially as improvements in the design of loaders render them more adaptable to varying seam conditions.

After the coal has been loaded underground, the next step is to convey it to the surface. Occasionally it makes the entire trip on a conveyor, but the common practice is to haul it in mine cars. Although horses and mules are still used to some extent to pull cars in both anthracite and bituminous mines, they have been replaced gradually by mechanical haulage. Electric locomotives, deriving their power from overhead trolleys or storage batteries, are used for haulage in most mines. The mine cars are gathered from the various working places, either by the main haulage locomotives or by smaller “gathering” locomotives, and are made up into trains, called trips. In drift mines, and in slope mines where the incline is slight the cars are hauled directly to the surface. However, where the incline is so steep that a locomotive cannot pull the cars up, they are usually drawn up by means of a cable. In shaft mines the cars are collected at the bottom of the shaft, dropped down an incline onto the cage of the hoist, and raised to the surface.

The mining processes so far described are those characteristic of large and medium-sized mines. In both the anthracite and bituminous industries there are a large number of small mines, which usually produce coal for local use and ship by truck. These truck or wagon mines operate with a minimum of mechanical equipment. Coal is mined and loaded entirely by hand, and haulage equipment is simple. In wagon mines which have drift entrances, as do most of those in the bituminous industry, the coal cars may be hauled to

⁷ *Ibid.*, pp. 799, 856.

the surface by mules, but more often they are pushed by the workers themselves. In anthracite or other wagon mines with shaft entrances, the shaft equipment is crude, in many cases consisting only of a windlass operated by hand or by gasoline engine.

Occupations.

The work of mining coal and preparing it for shipment to the consumer involves a multiplicity of tasks. The number of identifiable occupations is, however, much smaller, since most coal-mine workers perform several distinct tasks. Because of different mining methods, different seam conditions, and a wide variation in the scale of the operations, the nature and organization of the work vary in detail from mine to mine. But it is nevertheless possible to classify coal-mine workers in fairly definite occupational groups, which apply with certain modifications to all underground operations, with the exception of small truck and wagon mines, where there is little if any differentiation of jobs. The terms used in listing the various occupations are those most common in the industry.

The major group of underground occupations embraces the employees who do the basic work of undercutting, drilling, shooting down the coal, and loading it into mine cars at the working face. The occupations of the workers in this group are *miner*, *miner's helper* or *loader*, *undercutting-* or *shearing-machine operator*, his *helper*, *loading-machine operator*, his *helper*, *driller*, and *shot firer*. In unmechanized mines the *miners*, who under such circumstances are usually referred to as *pick miners*, undercut the coal with a pick, drill shot holes by hand, fire the shots, and pull down and load the coal into the mine cars by hand. The miners also lay track within their working places to bring the mine cars close to the coal to be loaded and set timber in their rooms as coal is removed. Each miner may be assisted by one or more *miners' helpers* or *loaders*, whose work consists chiefly in loading coal, but who may help with the various other tasks of the miners. Many boys have begun their work in mines in this occupation; especially in bituminous mines it has been customary for miners to take their sons into the mine as their helpers and so train them in the miner's craft.

Where mining processes are mechanized, the tasks usually performed by miners in unmechanized mines are likely to be divided among several specialized workers. Although undercutting machines may be operated by *machine miners* who retain their duties in connection with the blasting and loading of the coal, they are more often operated by specialized *machine operators*, who are frequently assisted by *machine operators' helpers*. Where power drills are used for making shot holes, a specialized *driller* may perform this task, instead of a miner or miner's helper. Frequently a specialized *shot firer* loads the explosives in the shot holes and fires them, even where mechanized mining equipment is not used. Coal may be loaded into cars by hand by the miners and their helpers; or mechanical conveyors, scrapers, or pit-car loaders may be used by the miners, in which case some hand shoveling is eliminated. Coal may also be loaded mechanically by a mobile loading machine operated by a specialized *loading-machine operator*, assisted by a *loading-machine operator's helper*. It is apparent that the greater the degree of mechanization in the mine, the

greater is the tendency to eliminate the miner's craft and replace it by a series of specialized occupations.

Employees engaged in haulage operations constitute a second distinct group of coal-mine workers, who are considerably smaller in number than those engaged in mining and related occupations. In this group are the *motormen*, who operate the motors or locomotives used to haul mine cars, and the *drivers*, who drive the horses or mules used to pull mine cars where haulage has not been mechanized. Motormen and drivers are commonly assisted by *motormen's* or *drivers' helpers*, who perform a variety of tasks, such as coupling and uncoupling cars, spragging cars (that is, braking by thrusting a stick between the spokes of a wheel), throwing switches, and acting as brakemen. In most mines, doors are constructed across haulageways at intervals in order to control the movement of the air current as required by the ventilation system. Workers who tend these doors, opening and closing them to permit a trip of mine cars to pass, are called *trappers* or *door boys*. Where boys are employed underground, this is often their first job.

Another haulage occupation, found only in shaft mines, is that of *bottom man*. Workers in this occupation take the loaded mine cars from a trip at the bottom of the shaft, push them onto the cage, signal the hoisting engineer, and perform related duties necessary to the movement of mine cars. In slope mines, where the loaded mine cars are hoisted up the incline by a cable arrangement, a motorman's helper, frequently known as a *rope rider*, hooks the cars to the cable and rides with the cars up the slope.

A third group of underground coal-mine workers are engaged in maintenance work. These maintenance employees vary in number from mine to mine but are always a smaller group than the miners and other workers employed at the face. The group includes *trackmen*, *brattice men*, *timbermen*, *rockmen*, *pumpmen*, *pipemen*, and *repairmen*, such as *electricians* and *machinists*. *Trackmen* lay, repair, move, and clean the tracks. *Brattice men* erect brattices or walls to direct the air currents as required by the ventilation system. *Timbermen* cut, frame, and put in place the timber used to hold up the roof. *Rockmen* remove rock from the roof or bottom of rooms or passageways where additional roof height is necessary; they also take down bad roof in haulageways and passageways as the necessity arises. *Pumpmen* operate and repair pumping machinery; and *pipemen* lay and repair pipes for air, steam, and water. There are also other repairmen, including *electricians* and *machinists*, who install and repair electrical and mechanical equipment.

In addition to the three main classes of underground employees—those engaged in mining and loading coal, in haulage, and in maintenance work—there are also mine foremen and fire bosses, who are responsible for underground operations, and perhaps some unskilled laborers who perform miscellaneous tasks.

Open-Cut Operations

Mining methods.

Open-cut operations, sometimes referred to as stripping operations, are quite different in principle from underground mining, the work

being carried on in open pits instead of by underground tunneling. These operations employ power shovels first to remove the dirt and rock overlying the coal seam and then to remove the coal itself. Although this process is of course limited in applicability to seams lying fairly near to or outcropping on the surface, stripping operations are now carried on in some seams which lie at an average depth of 50 to 60 feet below the surface.

The general plan of a stripping operation is first to remove the overburden of rock or soil from the coal in a cut perhaps 80 feet wide at the edge of the area to be stripped. The overburden is piled to one side in a spoil pile and the coal removed. A parallel cut is then made and the overburden dumped in the cut from which the coal has been recovered, the process being continued over the area to be mined. This method is modified somewhat when pitching seams are encountered, as in anthracite stripping. Where the seam pitches heavily, the cut follows the outcrop of the coal seam, the width of the cut being determined by the pitch of the seam and the depth to which it is economically practicable to strip. Frequently the overburden and the coal are removed by a scraper device known as a dragline operated from the surface at the head of the cut.

As a result of technical advances, the stripping shovels now used to remove the overburden are frequently electric-powered and mounted on caterpillar treads, instead of being track-mounted and operated by steam. Technical advances have also led to an increase in the size, range, and power of the shovels, many of which are now gigantic—with booms 100 or more feet long, dipper sticks up to 70 feet in length, and a dipper capacity as high as 33 cubic yards—and operate on voltages exceeding 4,000. In some operations all the overburden is removed with a dragline, which may have a boom length of 170 feet or more. Draglines are sometimes used to remove the topsoil only, a power shovel being used to strip the underlying rock or slate. Where blasting is necessary to loosen strata of solid rock, electric or engine-operated drilling equipment is used to drill either horizontal or vertical shot holes. Vertical holes are usually 6 inches in diameter; horizontal holes, 4 or 6 inches. The amount of explosives used is such as to loosen the overburden but not to displace it.

After the overburden has been removed with a power shovel, the surface of the coal seam is cleaned. As much dirt as possible is first removed by means of a tractor-operated bulldozer, a scraper operated by a dragline, or hand shoveling, and then the coal is swept either with mechanically operated steel brooms or with hand brooms and brushes.

After the coal has been cleaned, the next step is the recovery of the coal. Under some seam conditions the coal can be dug with a power shovel without any preliminary blasting, but in many seams it must first be loosened by blasting. Drilling may be done with a jackhammer or with an auger-type drill. Pellet powder or dynamite is used for shooting.

Frequently it is found advisable to make a vertical, or shearing, cut through the coal seam, by means of a channeling machine similar to the shearing machine used in underground mines. Shearing tends to confine the shot within the area sheared, thus leaving a straight edge along the spoil pile.

Some power shovels used to dig the coal are similar to those used in stripping the overburden, although they are smaller, the maximum capacity being about 6 cubic yards. Other shovels for digging coal are of a special design, such as the horizontal-thrust type. Occasionally a derrick or bank loader may be used. These shovels load the coal directly into motor trucks, trailers, or railroad cars, which haul it to the tippie or breaker.

Occupations.

Each stripping shovel, dragline, and loading shovel operates with a crew that works together as a unit and is referred to as a *stripping-shovel crew*, *dragline crew*, or *loading-shovel crew*. The size of the crew depends on the size of the equipment and the method of operation. It always includes an *engineer* or *operator*, who operates the shovel or dragline, and, where steam power is used, a *fireman*. If the shovel is very large, some other specialized occupations, such as that of *oiler*, may be found. The crew may also include *groundmen*, who assist in operating the equipment and in moving it forward as needed.

Where it is necessary to blast either the overburden or the coal itself, a *driller* and his *helper* do the drilling and a *shot firer* usually does the actual shooting of explosives. *Coal cleaners* operate the bulldozers or scrapers used to clean the coal, or they may perform this work manually, using picks, shovels, and wire brooms.

Since the coal is usually hauled to the tippie or breaker by steam locomotives or by trucks, the haulage occupations in stripping include those of *locomotive engineer*, *fireman*, and *brakeman*, or *truck driver*. In the few cases where regular electric mine-haulage equipment is used, the haulage employees would probably be classed as *motormen* and *motormen's helpers*. *Trackmen* lay the tracks used for haulage.

Stripping operations may also employ some general *laborers*, usually in cleaning up, in preparing roads where track haulage is used, and in digging drainage ditches for the removal of surface water.

Surface Operations

Processes.

Under the general heading of surface operations are included the haulage of coal from the mine entrance or the open pit to the tippie or breaker, the preparation of coal for the market, the loading of coal for shipment, and the operation of certain auxiliary mine departments, such as the repair shop and powerhouse. Although the complexity of the surface operations varies somewhat with the size of the mine, these basic surface processes are essential to the conduct of all underground and open-cut mines except small mines selling their coal entirely on a run-of-the-mine basis without grading or other preparation. In such cases the surface operations may be limited to the loading of coal into trucks, together with a small amount of repair work.

In open-cut mines coal is taken directly to the tippie or breaker by the trucks or cars into which it was loaded in the pit. Similarly, in drift mines, coal is usually taken to the tippie by a continuation of the same trip that brought it to the surface, although, where the drift is located high up in a mountainside, the coal may be hauled first to a top tippie and there transferred to a car of another type before being

dropped to the main tippie. In shaft and slope mines the tippie or breaker is usually located near the mine entrance, in which case the coal is dumped as soon as it reaches the surface. Occasionally the cars are re-formed into another trip for haulage to the tippie or breaker, where the coal is dumped by tilting the car.

The preparation of coal in the tippie or breaker is for the purpose of improving its quality and appearance through grading according to size, removal of slate and other impurities, and cleaning or washing to eliminate dust. The preparation of anthracite is usually a more complicated process requiring the use of more mechanical equipment and the employment of many more workers than that of bituminous coal, but the purpose is essentially the same in both cases.

In the bituminous industry most mines operate their own tipples, although in some instances several mines may use the same one. The tipples of small mines are usually crude wooden structures, but those of large mines are often permanent and relatively modern buildings of wood or concrete and steel. To permit movement of the coal by gravity, tipples usually have several elevations. The coal is graded for size by passing it over screens, which may be of the bar or of the perforated type. Screens of the latter type frequently serve as picking tables, at which workers are stationed to remove the slate or other impurities. However, special picking tables may be provided or the slate may be removed as the coal is loaded into the railroad cars. The coal is sometimes crushed or otherwise broken to reduce it to the desired size. Some modern tipples clean the coal mechanically by a wet-washing system or by a pneumatic process, and oil or other chemical treatments may be given to reduce dustiness further or to prevent freezing in transit. Coal is loaded by gravity directly from the tippie into railroad cars, sometimes through loading booms.

Anthracite breakers are frequently huge concrete and steel structures housing a great deal of heavy machinery. One breaker may prepare coal from several mines, the trend apparently being toward centralized breakers instead of individual breakers for each mine. Coal enters the breaker at the top, usually by conveyor though sometimes directly from the mine entrance where this is located above the breaker. The coal then travels down through the breaker, undergoing a continuous process of preparation. It is passed over shaker screens for grading to size and, where necessary, may also undergo crushing or breaking. Impurities are removed by a modified flotation process. The coal is agitated in a sand-and-water solution, and, being lighter than the slate or rock, floats and is removed from the top, while the impurities are removed at a different point. Anthracite is more closely graded for size than bituminous coal and more effort is made to clean it of dust and impurities. After the preparation processes have been completed, the coal is loaded by chutes into railroad cars or into trucks if it is for local shipment. Refuse material, such as slate, rock, and coal dust, is removed to a culm bank by some type of conveyor.

Occupations.

In underground coal mining the workers who are employed exclusively on the surface are a much smaller group than the underground workers. This is generally the case also in open-cut mining.

Many employees who do some work underground or in the pit of stripping operations, and who therefore are classed as underground

or open-pit workers for the purposes of this study, also do considerable work in the surface operations. This is especially true of the haulage employees. In drift and slope mines where the coal is taken to the tippie in the same trip that brought it to the surface, the crew that operated the trip underground continues to operate it on the surface; in open-cut mining the situation is similar. It is only in shaft and slope mines where the mine cars have to be re-formed into trips for further haulage, after being hoisted to the surface, that *motormen* and *motormen's helpers* are found who work exclusively on the surface. In addition, in shaft mines *topmen* are employed to take the cars from the cage and then either dump the coal or reassemble the cars into a trip for further haulage. The topmen also load the empty cars onto the cage and transmit signals to the *hoisting engineer*.

When the cars are received at the tippie or other unloading point, a *weighman* weighs the coal and credits it to the account of the miner who loaded it. A *check puller* then takes from the car the metal disc which was placed there as an identifying number by the miner who loaded the car.

The men employed in the tipples of bituminous mines constitute another distinct group of surface employees. *Tippie men* dump the coal from the cars, operate the shaker screens and other tippie machinery, and load the coal into railroad cars through a loading boom or chute. Pieces of slate or other impurities are removed by *slate pickers* working at picking tables or sometimes on the railroad car being loaded. When a railroad car is filled, a *car dropper* releases the brake and drops the car to a point where it can be made up into a train.

The employees in anthracite breakers may be classed together as *breaker men*, a term which covers all employees of the breaker. However, several occupations are often differentiated. For example, the man who has charge of the jig tables where slate is washed from the coal may be known as a *jig tender*. When the cone process is used in removing slate, the worker in charge may be known as a *cone man*. *Screen men* and *slate pickers* may also be employed to do much the same work as in bituminous-coal tipples. And there is often a *chute tender*, who opens and closes the chutes by which coal is loaded into railroad cars, the cars being then moved from the chutes to the railroad yard by a *car dropper*, as in bituminous tipples. In large breakers there may be other workers within the category of *breaker men*, but these employees commonly perform a variety of tasks and cannot be differentiated on the basis of their occupations.

The powerhouse is another surface department employing a few workers at almost every mine. *Engineers* and *firemen* comprise the powerhouse crew. These employees operate the boilers and generating apparatus necessary to provide steam for the hoisting engine and electricity for use underground and on the surface.

Since mining machinery and haulage equipment are subjected to hard usage and are in constant need of repairs and replacements, every mine operates a repair and maintenance shop. Among the skilled craftsmen commonly employed in these shops are *blacksmiths*, who sharpen cutter bars, bits, and other tools and do other repair work on metals, with the assistance of *blacksmiths' helpers*; *car repairmen*, who repair mine cars and locomotives; and other mechanical craftsmen, such as *carpenters*, *electricians*, *mechanics*, and *welders*. The

repair shops are located on the surface, but some of these craftsmen may at times work underground or in the pit of stripping operations.

Other maintenance occupations, which in general require less skill than those connected with the repair shops, are also found in the surface operations of many mines. These include the jobs of *track-men*, who make the constant inspections and repairs needed to keep the tracks in good condition, and of *clean-up men*, who keep the mine property free from accumulations of waste material and clean up coal spilled from cars and conveyors.

The officials employed outside mines are the mine superintendent, who is responsible both for the underground and for the surface operations, and the outside foreman and his assistants. A few mines employ one or more clerical workers, such as a timekeeper and a payroll clerk, in the office of the mine superintendent. In addition, some mines may employ a few workers about their surface operations in jobs that are not common to the industry as a whole.

Boys employed in surface work are likely to be assigned first to an unskilled job, such as that of slate picker, check puller, helper in the repair shop, or general clean-up man.

ACCIDENT HAZARDS

The great danger for young persons of work in or about coal mines is evident from all the available information on coal-mine accidents and accident hazards. Coal-mine workers face certain hazards that are present in other industries also, such as those resulting from the use of tools, the handling of heavy materials, and proximity to moving machinery. In addition, they face a number of hazards that are peculiar either to coal mining or to mining in general. Among these are falls of the mine roof, mine-haulage accidents, and explosions due to gas or coal dust. The hazards of coal-mine work are so numerous and widespread as to cause a high accident rate not only in the industry as a whole but also in almost all the various occupations which it embraces.

The ensuing discussion of hazards in the coal-mining industry first introduces statistics on the frequency and severity of accidental injuries in underground, open-cut, and surface operations and compares these injury rates with the corresponding rates in other industries. It then analyzes the causes of coal-mine accidents and, finally, presents statistical and descriptive material regarding the hazards of various coal-mine occupations.

Information on injury rates for coal-mine workers in the United States is limited almost entirely to that relating to workers of all ages, and unfortunately no current information based on American experience is available for the young-worker group separately. The data on coal-mine hazards in this report therefore relate chiefly to the hazards to persons of all ages, and the conclusions with regard to the hazards to young workers have been reached primarily on the basis of such evidence. The statement of principles made by the Children's Bureau Advisory Committee on Occupations Hazardous for Minors at its meeting on October 13, 1939, indicates the appropriateness of this procedure in stating:

* * * occupations particularly hazardous or detrimental to the health or well-being of workers in general are also particularly hazardous or detrimental to the health or well-being of minors under 18 * * *.¹

Frequency and Severity of Injuries to Coal-Mine Workers

Injury rates in different branches of coal mining.

An average of at least 67,800 fatal and nonfatal injuries^{1a} occurred annually in the coal mines of the country during the 5-year period 1933-37, according to surveys of the United States Bureau of Mines,

¹ Advisory Committee on Occupations Hazardous for Minors. *The Child* (published by the Children's Bureau), Vol. 4, No. 5 (November 1939), pp. 136-137.

^{1a} As used in this report, the term "injury" means a disabling injury—that is, one which arises out of and in the course of employment and which results in death, in permanent total or permanent partial disability, or in loss of time on any day other than that on which the accident occurred.

which cover approximately 90 percent of all active coal mines in the United States.² This number includes an annual average of about 1,300 workers killed or suffering permanent total disability, and about 1,700 suffering permanent partial disability (table 1).

TABLE 1.—Average number of industrial injuries occurring annually at coal mines, by extent of disability; United States, 1933-37

Extent of disability	All coal mines	Anthracite	Bituminous
All injuries	67, 807	18, 433	49, 374
Fatal and permanent total	1, 334	261	1, 073
Permanent partial	1, 678	136	1, 542
Temporary	64, 795	18, 036	46, 759

Source: Compiled from Coal-Mine Accidents in the United States, 1933, 1934, 1935, 1936; and Employment and Accidents at Coal Mines in the United States, 1937, H. S. S. No. 268 (mimeographed). Bureau of Mines, U. S. Department of the Interior, Washington.

The frequency rate of disabling injuries, including fatalities and nonfatal injuries of all degrees of severity, was 87.86 per 1,000,000 man-hours of employment in the coal-mining industry as a whole during the 5 years 1933-37. For the anthracite industry alone, the corresponding frequency rate was 118.23, about one and one-half times as high as the rate (80.17) for bituminous mining (table 2). It thus appears that the chance of injury is greater in anthracite than in bituminous mines, although, because the bituminous industry is much larger than the anthracite, it accounts for a majority of the coal-mine injuries occurring in the United States.

TABLE 2.—Frequency rates of fatal and nonfatal injuries for coal mines, by type of mining operation; United States, 1933-37

Type of mining operation	Frequency rate ¹		
	All injuries	Fatal injuries	Nonfatal injuries
All coal mines	87. 86	1. 63	86. 23
Underground	95. 85	1. 84	94. 00
Open-cut	74. 46	. 91	73. 55
Surface	47. 87	. 62	47. 25
Anthracite	118. 23	1. 58	116. 65
Underground	132. 61	1. 88	130. 73
Open-cut	69. 18	. 99	68. 20
Surface	77. 38	. 64	76. 74
Bituminous	80. 17	1. 64	78. 53
Underground	87. 56	1. 83	85. 73
Open-cut	77. 35	. 86	76. 49
Surface	36. 82	. 61	36. 20

¹ Number of disabling injuries per 1,000,000 man-hours of employment.

Source: Compiled from annual surveys of coal-mine accidents made by the U. S. Bureau of Mines. For basic data see appendix B, table III, p. 49.

² The Bureau of Mines makes annual surveys of coal-mine accidents by sending questionnaires to all mines that produced 1,000 or more tons of coal or employed 4 or more men during the calendar year, with the exception of unauthorized mines in the Pennsylvania anthracite fields. Some mines below the specified size limits send in reports on injuries which are also included in the compilations. The statistics compiled are intended to cover all disabling injuries occurring at the reporting coal mines, except that injuries to office workers are excluded unless they occurred while these workers were assisting in rescue work after an explosion or other disaster.

The frequency rate of fatal injuries in coal mining as a whole during the same 5-year period was 1.63 per 1,000,000 man-hours of employment. The corresponding fatality rates for the anthracite and bituminous industries were respectively 1.58 and 1.64. This shows that there is little difference between the two branches of coal mining in frequency of fatal injuries. Nonfatal injuries, on the other hand, occur much more often in anthracite than in bituminous mines, in proportion to man-hours worked (table 2).

The most hazardous type of mine operation in the anthracite and bituminous industries combined is underground work, with open-cut mining second and surface operations third in degree of hazard.⁴ As table 2 shows, this ranking holds true for the frequency rates of all disabling injuries, of fatal injuries, and of nonfatal injuries, both in coal mining as a whole and in the bituminous industry. In anthracite mining it holds true only for fatal injuries, nonfatal injuries being somewhat more frequent in surface than in open-cut operations.

Coal-mine injury rates compared with those for other industries.

The accident hazard to coal-mine workers can best be judged by comparing the injury rates for coal mining with those for other industries. According to data compiled from annual surveys of industrial injuries made by the United States Bureau of Labor Statistics, the frequency rate of all disabling injuries for manufacturing as a whole was 17.74 per 1,000,000 man-hours worked during the 5-year period 1933-37.⁵ This compares with a rate of 87.86 for coal mining as a whole. The type of coal-mining operation with the highest frequency rate, underground work in anthracite mining, had a rate of injury many times as great as that for manufacturing. Even the branch of mining with the lowest frequency rate, surface operations in the bituminous industry, had a considerably higher rate of disabling injuries than did manufacturing.

Of the industries for which the United States Bureau of Labor Statistics publishes industrial-injury rates (coal mining is not included), logging was the one with the highest frequency rate (99.64) for the 1933-37 period.⁶ High as this rate is, the frequency rate for anthracite mining as a whole (118.23) is considerably higher and that

⁴ In the accident statistics presented in this report, which are based on the data compiled from the annual surveys of the U. S. Bureau of Mines, all work below the surface, including that in shaft, slope, and drift entrances, is classified as underground work. Open-cut mining means, in general, work in the pit of stripping operations, work outside the pit being classified as surface operations along with comparable work outside underground mines. However, the category of open-cut mining also includes a number of injuries in washery and dredging operations in the anthracite industry. Washeries are ordinarily classified with surface work, but in some years during the period 1933-37 they were grouped by the Bureau of Mines with open-cut mining and could not be segregated. Dredging is regularly classified by the Bureau of Mines with open-cut mining and is not separable from it (for exception, see footnote 1, appendix B, table III, p. 49). Although the exact number of washery and dredge injuries is unknown, it is believed to be too small to affect significantly the rates and percentages used.

⁵ Calculated from data published by the U. S. Bureau of Labor Statistics in the following reports:

Accidents in 30 Manufacturing Industries, 1933 and 1934, Monthly Labor Review, Vol. 43, No. 4 (October 1936), table 1, pp. 847, 848.

Injury Experience in 30 Manufacturing Industries, 1935 and 1936, Monthly Labor Review, Vol. 46, No. 3 (March 1938), table 2, pp. 676, 677.

Industrial Injuries in the United States During 1937, Monthly Labor Review, Vol. 48, No. 3 (March 1939), table 3, pp. 601-607.

The statistics on injuries in nonmining industries, collected annually by the U. S. Bureau of Labor Statistics, are believed to be comparable with the statistics of the U. S. Bureau of Mines, since the two Bureaus use much the same methods in making their surveys. The main difference is that the Bureau of Labor Statistics selects the firms to receive questionnaires on a representative-sample basis, while the Bureau of Mines approaches complete coverage of the coal-mining industry.

⁶ Rate calculated from data taken from the sources listed in footnote 5.

for underground work in anthracite mines (132.61) is higher still. On the other hand, the frequency rates for the bituminous industry and for open-cut and surface operations in the anthracite industry are lower than the rate for logging.

All branches of coal-mine work, except surface operations at bituminous mines, had higher frequency rates than did sawmilling, the industry with the second highest rate (61.25) among those for which the Bureau of Labor Statistics computes injury rates.

The National Safety Council, in its annual publication *Accident Facts*, ranks 30 industries according to their frequency rates. Of these industries mining, which is heavily weighted by coal mining although it includes metal and other nonmetal mining as well, had the highest frequency rate in 1933 and was second only to lumbering in each of the 5 succeeding years.⁷

With respect to the frequency of fatal injuries, coal mining compares even less favorably with other industries than it does in the frequency of all disabling injuries. According to data compiled from surveys of the Bureau of Labor Statistics, the frequency rate of fatal injuries for manufacturing as a whole was 0.12 per 1,000,000 man-hours worked during the period 1933-37. The comparable fatality frequency rates for coal mining as a whole, based on Bureau of Mines data, and for the bituminous and anthracite industries separately were respectively 1.63, 1.64, and 1.58. Even the least hazardous type of coal-mine operations, surface work in bituminous mining, had a fatality frequency rate of 0.61, several times as great as that for manufacturing.

Of the industries surveyed by the Bureau of Labor Statistics, none had so high a fatality frequency rate as either bituminous or anthracite mining.⁸ The exceedingly high rate of fatal injuries in coal mining is explained mainly by the great frequency with which such injuries occur in underground operations.

In *Accident Facts* the National Safety Council ranks by standard severity rate (that is, the number of days lost per 1,000 man-hours of employment) the 30 industries for which it publishes industrial-injury rates. In each of the years 1933-38 the mining industry, covering chiefly coal mining, had a higher severity rate than any other industry.

In any industry or branch of industry in which the injury rates are as high as those in coal mining, the presumption is that all or nearly all occupations in it are highly hazardous for the workers involved, regardless of their age. In this discussion the question at issue therefore appears to be not so much what occupations in the coal-mining industry are hazardous for young workers as what occupations, if any, in this industry are not particularly hazardous for the employment of minors 16 and 17 years of age.

⁷ The industrial-injury statistics for mining published by the National Safety Council are based on the experience of mines participating in the annual safety contests conducted under the auspices of the Bureau of Mines. These mines are much smaller in number than those included in the Bureau's Nation-wide surveys and are probably much less representative of all sizes and types of mines in the country. In the case of industries other than mining, the National Safety Council in general bases its statistics on the experience of firms belonging to the council.

⁸ This comparison is based on injury experience over the 5-year period 1933-37 for coal mining and over the 3-year period 1936-38 for other industries. Fatality frequency rates have not been computed for the 5-year period 1933-37 for the individual industries surveyed annually by the Bureau of Labor Statistics.

Hazards of Underground Operations

Causes of accident.

The frequent and severe injuries to workers in underground coal-mine operations are the result of a variety of accident hazards, such as explosions of gas or coal dust, which often kill many workers in a single disaster, and hazards incident to the handling of coal or other materials, which result in most cases in nonfatal injuries. An understanding of the nature and relative importance of these accident hazards is essential to an accurate assessment of the risk to coal-mine workers in various occupations. Such an understanding is best obtained through an analysis of the causes of coal-mine injuries, as reported in the surveys of the Bureau of Mines.

Relative importance of the different causes of accident.—The most important single cause of coal-mine accidents, judging by the number of disabling injuries resulting, is falls of roof, face, or rib (that is, falls of rock or coal from the mine roof, a working face, or the side of a room or haulageway other than a working face). During the 5 years 1933–37, this cause was responsible for 28 percent of the disabling injuries, fatal and nonfatal, which occurred underground in coal mines reporting to the Bureau of Mines and for a much larger proportion (58 percent) of the fatalities (table 3). Mine cars and mine locomotives were the cause of accident that stood second in importance, accounting for 22 percent of all the disabling injuries reported and for 19 percent of the fatalities.

The other accident causes which rank high among those responsible for disabling injuries underground are handling materials, hand tools, machinery, falls of persons (exclusive of falls from cars or down shafts, which are classified elsewhere), and other falling materials or objects (exclusive of those handled by the injured worker or classified under other headings, such as falls of roof, face, or rib). These other hazards are given in the order of their relative importance as a cause of injury. Each was responsible for at least 4 percent of the underground injuries (fatal and nonfatal) reported in the surveys of the Bureau of Mines (table 3). The number of fatal injuries due to each of these causes is relatively small, however, and for this reason some other causes which account for a much smaller total number of injuries nevertheless rank higher as causes of fatalities.

The following are the agencies which rank after mine cars and locomotives as causes of fatal injuries underground: Explosions of gas or coal dust, electricity, explosives, and machinery. These causes include all those which were responsible for as much as 2 percent of the fatalities occurring underground in all types of coal mines during the period under consideration.

Although all these various types of hazard exist to some extent both in bituminous and in anthracite mines, there are some marked differences in the extent to which they affect workers in the two branches of coal mining. In bituminous mining, as in the coal-mining industry as a whole, falls of roof, face, or rib constitute the most important cause both of fatal and of nonfatal injuries; in anthracite mining they stand first as a cause of fatalities but second to the handling of materials as a cause of nonfatal injuries. Handling materials (in which the most important element is the handling of coal after it has been mined but

which also includes the handling of rock, timber, and other materials) seldom leads to fatalities, but in anthracite mines it causes a large number of nonfatal injuries. The pitch of the anthracite seams and breasts greatly increases the difficulty of handling materials. Furthermore, in mines with pitching seams much of the coal is conveyed down chutes to a different level for loading. Timber used for mine props, portable hoists, and other material must also be handled up or down such chutes, and this involves difficulties of handling and danger from resulting falls of material.

TABLE 3.—*Causes of fatal and nonfatal injuries occurring underground in coal mines; United States, 1933-37*

Cause of injury	All injuries		Fatal injuries		Nonfatal injuries	
	Number	Percent distribution	Number	Percent distribution	Number	Percent distribution
All coal mines						
All causes.....	303, 104	100. 0	5, 826	100. 0	297, 278	100. 0
Falls of roof, face, or rib.....	86, 170	28. 4	3, 400	58. 3	82, 770	27. 8
Mine cars and mine locomotives.....	65, 370	21. 6	1, 122	19. 3	64, 248	21. 6
Handling materials.....	53, 485	17. 7	42	0. 7	53, 443	18. 0
Hand tools.....	28, 597	9. 4	14	0. 2	28, 583	9. 6
Machinery.....	18, 024	6. 0	167	2. 9	17, 857	6. 0
Falls of persons ¹	15, 045	5. 0	39	0. 7	15, 006	5. 0
Falling material or objects.....	12, 190	4. 0	44	0. 8	12, 146	4. 1
Electricity.....	4, 357	1. 4	262	4. 5	4, 095	1. 4
Explosives.....	2, 542	0. 8	216	3. 7	2, 326	0. 8
Explosions of gas or coal dust.....	1, 988	0. 7	314	5. 4	1, 674	0. 6
Shaft and slope.....	1, 301	0. 4	89	1. 5	1, 212	0. 4
All other.....	14, 035	4. 6	117	2. 0	13, 918	4. 7
Anthracite						
All causes.....	77, 137	100. 0	1, 093	100. 0	76, 044	100. 0
Falls of roof, face, or rib.....	16, 373	21. 2	649	59. 4	15, 724	20. 7
Mine cars and mine locomotives.....	9, 249	12. 0	148	13. 6	9, 101	12. 0
Handling materials.....	20, 612	26. 7	8	0. 7	20, 604	27. 1
Hand tools.....	7, 164	9. 3	1	0. 1	7, 163	9. 4
Machinery.....	2, 655	3. 5	13	1. 2	2, 642	3. 4
Falls of persons ¹	6, 165	8. 0	25	2. 3	6, 140	8. 1
Falling material or objects.....	6, 015	7. 8	22	2. 0	5, 993	7. 9
Electricity.....	936	1. 2	24	2. 2	912	1. 2
Explosives.....	838	1. 1	78	7. 1	760	1. 0
Explosions of gas or coal dust.....	918	1. 2	64	5. 9	854	1. 1
Shaft and slope.....	563	0. 7	31	2. 8	532	0. 7
All other.....	5, 649	7. 3	30	2. 7	5, 619	7. 4
Bituminous						
All causes.....	225, 967	100. 0	4, 733	100. 0	221, 234	100. 0
Falls of roof, face, or rib.....	69, 797	30. 9	2, 751	58. 1	67, 046	30. 3
Mine cars and mine locomotives.....	56, 121	24. 8	974	20. 6	55, 147	24. 9
Handling materials.....	32, 873	14. 6	34	0. 7	32, 839	14. 8
Hand tools.....	21, 433	9. 5	13	0. 3	21, 420	9. 7
Machinery.....	15, 369	6. 8	154	3. 3	15, 215	6. 9
Falls of persons ¹	8, 880	3. 9	14	0. 3	8, 866	4. 0
Falling materials or objects.....	6, 175	2. 7	22	0. 5	6, 153	2. 8
Electricity.....	3, 421	1. 5	238	5. 0	3, 183	1. 4
Explosives.....	1, 704	0. 8	138	2. 9	1, 566	0. 7
Explosions of gas or coal dust.....	1, 070	0. 5	250	5. 3	820	0. 4
Shaft and slope.....	738	0. 3	58	1. 2	680	0. 3
All other.....	8, 386	3. 7	87	1. 8	8, 299	3. 8

¹ Excludes falls from cars and down shafts.

The frequency with which anthracite workers suffer nonfatal injuries underground due to handling materials largely explains the much higher frequency rate of nonfatal injuries in the anthracite industry than in the bituminous (table 2). However, there are certain other types of accidents which also occur oftener in anthracite than in bituminous mines and which also result mainly in nonfatal injuries—for example, accidents due to falls of persons. The greater frequency in anthracite mines of injuries due to falls of persons apparently results from the pitch of the anthracite rooms or breasts. When miners work on a sharply pitching floor, as they do in many anthracite mines, they are obviously in greater danger of stumbling or slipping (the most common type of accident in the category of falls of persons) than are miners who work on a horizontal or nearly horizontal floor, as in most bituminous mines. Moreover, there is in anthracite mines the additional hazard of falls of persons down chutes connecting different mining levels.

Occupational incidence of the different causes of accident.—The accident hazards involved in underground operations are not limited to any one occupation or group of occupations, but instead affect all underground workers to a greater or less degree.

Falls of roof, face, or rib, the foremost cause of injuries to underground coal-mine workers, occur more frequently at the working face than elsewhere in the mine, but falls of roof and rib often take place also in haulageways or other places not at the face. Although no current statistical information is available regarding the exact location of roof-fall accidents, the data contained in a study of fatal injuries in the bituminous mines of Pennsylvania during the 5 years 1926–30 are believed to be indicative of present conditions. Of the 1,052 fatalities due to falls of roof and coal which were included in this survey, 83 percent were the result of falls that occurred at the working face, but 11 percent resulted from falls on a roadway, entry, or slope, and the remaining 6 percent from falls that occurred in the workrooms but not at the face.⁹

As would be expected from the location of these roof- and coal-fall accidents, the large majority (83 percent) of the fatal injuries were to workers employed as miners, loaders, cutting-machine operators, drillers, and shot firers, occupations involving constant work at the face. However, some workers in almost every other underground occupation were included among those killed, 10 percent being maintenance employees; 4 percent, haulage employees; 2 percent, supervisory employees and the remaining 1 percent, general laborers. (Appendix B, table IV, p. 49.)

The conclusion to be drawn from these figures on fatalities in the Pennsylvania bituminous industry from 1926 to 1930 is plainly that falls of roof and coal constitute a hazard to all underground workers, although this hazard is greatest in the case of miners and other workers employed at the face. This conclusion is supported by an analysis of the 173 fatalities due to falls of roof and coal which occurred in West Virginia coal mines during 1939. Of these 173 fatal injuries, 82 percent were to miners, machine operators and their helpers, drillers, and shot firers; but 10 percent were to maintenance

⁹ How and Why Fatalities Occurred in Pennsylvania Bituminous Coal Mines During the Five-Year Period 1926–30, by W. J. Fene, p. 9 (processed). Information Circular 6505. U. S. Bureau of Mines. Washington, September 1931.

employees, 5 percent to haulage employees, and 3 percent to foremen and assistant foremen. (Appendix B, table V-a, p. 50.)

Mine cars and locomotives, the second most frequent cause both of fatal and of nonfatal injuries in the coal-mining industry of the United States, also constitute a hazard to all or almost all underground workers. Nearly every underground worker has occasion to ride on or stand near moving trips either while at work or while going to and from his working place and is to that extent exposed to the hazard of haulage accidents. However, this hazard is naturally greatest in the case of haulage employees, who spend their entire working time in proximity to haulage equipment.

The study of fatal injuries in Pennsylvania bituminous mines already referred to included 307 fatalities in which mine cars and mine locomotives were involved. Forty-three percent of these fatal injuries were to workers in haulage occupations. (Appendix B, table VI, p. 51.) This figure indicates a much greater frequency of injuries due to mine cars and locomotives among haulage employees than among all underground workers, since employees in these occupations constituted only about 9 percent of all workers employed underground in Pennsylvania bituminous mines during the same period (table 4). However, the study also shows that such injuries often happen to workers in a variety of occupations not directly concerned with haulage. Of the 307 workers fatally injured, 44 percent were miners, drillers, and cutting-machine operators and their helpers; 9 percent were trackmen, timbermen, and other maintenance employees; 3 percent were mine foremen or fire bosses; and 1 percent were general laborers.

Haulage employees constituted a majority (35) of the 50 workers fatally injured in haulage accidents underground in West Virginia coal mines during 1939. But 10 of the workers killed were miners, machine operators, or their helpers; 3 were maintenance employees; 1 was a foreman; and 1 a laborer not otherwise specified. These figures serve to verify the conclusions drawn from the Pennsylvania study that mine cars and locomotives constitute a hazard to workers in all underground occupations, though especially to those regularly employed in haulage work.

Explosions of gas or coal dust, the third most frequent cause of fatal injuries in underground coal-mine operations in the United States, are likely to kill or seriously injure all workers in the area of the explosion. (table 3). In bituminous mines, where the coal dust is combustible, an explosion may spread throughout a large part of the mine, injuring workers in all underground occupations. In anthracite mines explosions tend to be more localized, since anthracite dust is apparently nonexplosive under normal mining conditions and explosions are therefore limited to gaseous areas. Even localized explosions, however, are likely to injure workers in many occupations.

Accidents due to electricity, the fourth most frequent cause of fatalities underground, also have a wide occupational coverage. Injuries from this cause, which include only electric shocks and burns, occur most often when workers come in contact with trolley wires, though sometimes they are caused by contact with haulage locomotives, machine feed wires, power or lighting circuits, or other electrical appa-

ratus. Since nearly all underground workers face the possibility of such accidents, the workers injured are likely to be in a variety of occupations, as were the 13 West Virginia workers fatally injured in underground accidents due to electricity during 1939. (Appendix B, table V-a, p. 50.) The occupations of these workers were as follows:

<i>Occupation</i>	<i>Number of workers fatally injured</i>
All occupations-----	13
Miners and loaders-----	4
Cutting- and loading-machine operators and their helpers--	1
Motormen, drivers, and their helpers-----	3
Timbermen and rockmen-----	2
Trackmen-----	3

Explosives and machinery, which are the only other causes of accident that accounted for as much as 2 percent of the fatal injuries to underground workers in the United States during the 5 years 1933-37, probably do not cause injuries to so wide an occupational group as do the causes of accident already discussed. Injuries due to explosives undoubtedly happen most often to miners, shot firers, and other workers whose jobs require them to handle and fire the explosives, although if explosives are improperly handled they may cause injuries to any employees who happen to be in the vicinity. The experience of West Virginia during 1939 indicates that injuries due to machinery occur most often to machine operators and their helpers, the workers most continuously exposed to machine hazards. But here again, cases are reported of injuries to workers in other occupations who happened to come too close to the machinery.

The other accident causes that require mention because of the large number of nonfatal injuries to underground workers in the United States resulting from them are handling materials, hand tools, falls of persons, and falling material or objects. All underground workers face the possibility of injury due to causes within these general categories. However, such accidents apparently occur more often at the working face than elsewhere in the mine and, as has already been mentioned, more often in anthracite than in bituminous mines because of the special hazards of work in the pitching anthracite seams.

Hazards of the various occupations.

All underground employees are to some extent exposed to most of the serious hazards of underground operations. This conclusion is indicated by the preceding analysis of the important causes of coal-mine accidents. However, it is also apparent from this analysis that all the causes of accident discussed, with the possible exception of explosions and electricity, tend to affect some occupational groups more than others. There are known to be some additional hazards that seriously affect particular occupations, although they do not rank high as causes of accident when all underground workers are considered together.

To indicate whether or not all underground occupations are particularly hazardous either for workers of all ages or for those under 18, it will be helpful to consider these occupations from the standpoint of their differences in hazard. In this discussion of hazard according to occupation, the available statistical data on the risk of the different

occupations will be considered together with technical information regarding the most serious hazards of each occupation. However, no attempt will be made to mention all the general hazards of underground work in connection with each occupation under discussion.

Miners, machine operators, and other workers at the face.—The study of fatalities in Pennsylvania bituminous mines during the 5 years 1926-30 is the most comprehensive and recent source of information on the frequency of injuries to workers in different underground occupations. This study showed a rate of fatal injuries per 1,000 workers employed in occupations connected with mining and loading at the face, which was about the same as the average for all underground workers.¹⁰ Of the four occupational groups commonly stationed at the face for which such rates were available (cutting-machine operators and helpers, machine miners, pick miners, and shot firers), all but one had a fatality rate approximately as high as or higher than the average for underground workers (table 4). The one exception was the shot firers, a very small occupational group made up of mature men of long experience, able quickly to detect and guard against dangerous conditions.

TABLE 4.—Occupations of underground workers fatally injured in bituminous mines; Pennsylvania, 1926-30¹

Occupation	Average number of workers employed yearly	Average number of fatal injuries per year	Average number of fatal injuries per year for each 1,000 workers
All occupations.....	131,325	308.4	2.4
Mining and loading.....	98,992	228.0	2.3
Pick miners.....	33,067	72.0	2.2
Machine miners.....	58,353	133.0	2.3
Cutting-machine operators and helpers.....	6,616	21.6	3.3
Shot firers.....	956	1.4	1.5
Haulage.....	12,363	38.0	3.1
Motormen.....	3,376	9.6	2.8
Drivers.....	4,666	12.6	2.7
Motormen's or drivers' helpers.....	4,321	15.8	3.7
Maintenance.....	11,031	26.2	2.4
Rockmen and timbermen.....	3,033	16.0	5.3
Trackmen.....	4,509	6.0	1.3
Pumpmen and pipemen.....	1,644	2.0	1.2
Brattice men.....	810	.6	.7
Electricians.....	1,035	1.6	1.6
Supervisory.....	3,524	5.6	1.6
Mine foremen and assistant mine foremen.....	2,668	3.4	1.3
Fire bosses.....	856	2.2	2.6
All other.....	5,415	10.6	2.0

¹ Excludes workers fatally injured by explosions.

Source: How and Why Fatalities Occurred in Pennsylvania Bituminous Coal Mines During the Five Year Period 1926-30, Information Circular 6505, table 3, p. 6. U. S. Bureau of Mines.

¹⁰ This measure of the frequency of fatal injuries was used because man-hour data were not available. Since the working hours of all underground employees tend to be much the same, the rates are believed to be a fairly satisfactory indication of the relative frequency of fatal injuries to workers in different underground occupations.

The many fatal injuries to miners and machine operators are largely explained by the continuous exposure of these workers, during their hours of employment, to the grave dangers of work at the face. Of these much the most important, especially as a cause of fatal injuries, is falls of roof and coal. Most workers stationed at the face are exposed also to a number of hazards which apply especially to their occupations. Thus, pick miners are the workers most exposed to the danger of accidents due to hand tools, while shot firers and miners who fire their own shots are the ones most in danger of accidents due to the handling and use of explosives. Where miners shoot the explosives, the hazard of premature or delayed shots or other explosives accidents tends to be greater than where shot firers are employed, since these experienced and specialized workers are usually more skilled than miners in the handling of explosives.

The introduction of machines underground creates additional hazards to workers employed in the vicinity, although these hazards may be offset at least in part by an increase in supervision and in accident-prevention work. The moving of such large and heavy objects as cutting machines, mobile loading machines, or drill rigs in the confined spaces underground involves considerable danger of accident. When cutting machines and drills are in operation, their sharp cutting edges constitute another hazard. And when loading devices are in use, they involve the hazard of contact with moving parts, such as conveyor belts or chains and the moving arms or gathering head of mobile loading machines, as well as the danger from reciprocating parts in certain types of loaders.

All mechanized equipment, whether mining machines or loading apparatus, involves the hazard of accidents due to electricity. Since the wiring is always temporary and most machines operate at 250 volts D. C., this hazard may be very serious. Furthermore, the use of machines usually increases the dustiness of the operations and therefore the danger of explosions, especially if the machines are of types not classified as permissible by the United States Bureau of Mines. Machine mining may also lead to falls of roof that could otherwise have been prevented. The vibration which attends the operation of machines may tend to loosen the roof, and the noise of the machine may make it impossible to hear the roof working. In addition, when cutting or loading machines are in place, it is often difficult, if not impossible, to timber the roof properly.

The effect of these hazards is to create a serious danger of accident among the machine operators and helpers and, to a less extent, among the machine miners, who spend only part of their time in operating the machines. In Pennsylvania bituminous mines from 1926 to 1930 cutting-machine operators and helpers had the highest fatality rate per 1,000 workers, and machine miners the second highest fatality rate of the four occupational groups commonly working at the face for which such information was available. Fatality rates were not available for the occupations of driller and loading-machine operator and helper, but the hazards of these occupations are believed to be comparable with those faced by the cutting-machine operators and helpers.

Altogether, it is apparent that no young person working at the face has a safe working environment regardless of his occupation or type of work and regardless of the extent to which he is supervised by a responsible and experienced worker.

Haulage employees.—The employees engaged in haulage occupations, who are a much smaller group than those employed in mining and related work, had an average annual fatality rate of 3.1 per 1,000 employees, according to the study of the Pennsylvania bituminous industry already cited (table 4). For motormen, drivers, and their helpers (the three groups of haulage employees for which separate data were available) the comparable fatality rates were respectively 2.8, 2.7, and 3.7. Each of these rates was higher than the average fatality rate for all underground workers (2.4) and also than that for miners and other workers stationed at the face (2.3).

The greater-than-average frequency of fatal injuries to haulage employees is explained by the constant exposure of these workers to the hazards of mine transportation, including both the hazard of accidents due directly to mine cars and locomotives and the risk of injuries from other causes, such as contact with the trolley wires. The hazards of the first type include being crushed between cars or between car and rib, being run over by a car or locomotive, or being injured in derailments. The danger of such accidents is aggravated by the fact that mine haulageways are usually no wider than necessary to permit the passage of a trip, that they are not always lighted, and that in many rooms the tracks are laid in a temporary and insecure manner which increases the chance of derailments. Although all haulage employees are exposed to the hazard of injuries from mine cars and locomotives, the helpers appear to be in greater danger than the motormen or drivers. The helpers frequently have to perform very hazardous tasks about moving trips, such as jumping on and off the trip, coupling, uncoupling, and spragging cars, and throwing switches. It is probably for this reason that, according to the figures for the Pennsylvania bituminous industry, helpers tend to have a higher fatality rate than drivers and motormen, whose jobs consist mainly in operating the trip.

Trappers also appear to be in serious danger of injury by mine cars and locomotives, although no injury rates are available for this occupation. While opening or closing doors, trappers are exposed to the danger of being run over by cars or locomotives. Sometimes trappers throw switches, a task which involves the hazard of tripping and falling in front of moving cars and also of being caught under the car or between the car and the rib in the derailments that often occur at switches.

Of the hazards that are connected with haulage work but are not occasioned directly by the mine cars and locomotives, one of the most important is electricity. Where haulage is mechanized, all haulage employees are subject to the danger of electric shocks or burns, especially since the trolley wires are of necessity bare.

Another group of hazards to which certain haulage employees are subject are those connected with the haulage of materials up and down shafts or slopes. These hazards include falling down the shaft, being crushed between the cage and the bottom of the shaft, falls of materials from the cage or car, and accidents due to the breaking

of cables. Bottom men in shaft mines and rope riders in slope mines are the underground employees in most serious danger of such accidents. Both of these groups of employees also face the hazard of accidents due to mine cars and locomotives, since their jobs commonly include such tasks as coupling, uncoupling, and spragging cars as well as work in connection with the hoists.

All jobs connected with the haulage of mine cars, including that of trapper, the traditional boy's occupation underground, appear to involve serious hazards. Even if it were possible to provide boys working as trappers with comparatively protected working places, it is unreasonable to expect that these young workers would not, on occasion, leave their regular working places and be exposed to the typical hazards of haulage work.

Maintenance employees.—The degree of hazard to workers in the maintenance group varies greatly from occupation to occupation. Rockmen and timbermen probably have the most hazardous jobs connected with coal mining, at least insofar as frequency of fatal injuries is concerned. In the study of the Pennsylvania bituminous industry from 1926 to 1930 it was found that the average annual fatality rate for rockmen and timbermen was 5.3, more than twice as high as the rate (2.4) for all underground workers and higher than that for any other occupation studied. The primary reason for this high fatality rate is that rockmen and timbermen are employed to remedy bad roof conditions and are therefore required almost constantly to be in the most dangerous parts of the mine, where falls of roof are most likely to take place. Both these groups of workers are also subject to accidents due to the handling of heavy rock or timber, and timbermen may suffer injuries from the saws and axes which they use in cutting and framing mine props. However, accidents of these last two types usually lead to nonfatal rather than fatal injuries.

The other groups of maintenance employees for whom fatality rates were available in the Pennsylvania study were trackmen, pumpmen and pipemen, brattice men, and electricians. Each of these occupational groups had a fatality rate which was not only much lower than that for rockmen and timbermen but also below the average for all underground workers (table 4). Employees in these occupations do most of their work in the haulageways and thus are spared the special hazards of work at the face. However, these workers are to some extent exposed to all the hazards of underground work and in addition face some marked dangers which apply particularly to their occupations. Thus, trackmen are apparently in greater danger of accidents due to mine cars and locomotives than any other underground workers except the haulage employees themselves. Electricians have to handle dangerous, high-voltage electrical equipment. And all repairmen, pumpmen, and pipemen frequently have to travel through worked-out areas and little-used entries, where ventilation is often inadequate and the danger from roof falls is greater than along main haulageways. Furthermore, repairmen, pumpmen and pipemen, and brattice men as well, often work alone and thus may be out of reach of help when an accident occurs. Maintenance occupations therefore appear to be unsuitable for young persons because of the hazards involved.

Hazards of Open-Cut Operations

Causes of accident.

Workers employed in open-cut operations are in somewhat less danger of injury than those employed underground. According to statistics of the United States Bureau of Mines already cited, the frequency rate of disabling injuries for open-cut operations in the anthracite and bituminous industries combined (74.46) is about one-fifth lower than that for underground work (95.85), but it is nevertheless several times higher than the average rate for manufacturing as a whole (17.74).

The accident hazards connected with open-cut mining differ somewhat from those encountered underground. Statistics based on data compiled by the Bureau of Mines indicate that the most important single cause of disabling injuries, fatal and nonfatal, in open-cut mining is handling materials, such as rock, coal, and railroad equipment, and that the next most important cause is falls of persons, including falls of persons on the same level and from one level to another. During the 5-year period 1933-37, handling material accounted for 16 percent and falls of persons for 12 percent of all injuries in open-cut operations (table 5).

The use of hand tools was the third most frequent cause of accident, accounting for 10 percent of all the injuries reported. The other accident hazards that are important as a cause of all disabling injuries to workers in stripping operations are, in descending order of their importance, power shovels, scrapers or buckets, falling objects (other than coal), falls or slides of coal or overburden, and drills. Each of these hazards was responsible for 4 percent or more of the total number of disabling injuries.

The hazards of open-cut operations appear to be similar, both in nature and in degree, in the anthracite and bituminous industries. The two most frequent causes of injury, handling materials and falls of persons, were responsible for very nearly the same proportion of the disabling injuries reported in each of the two branches of coal mining. Handling materials accounted for 15 percent of all injuries reported in anthracite mining and for 16 percent of those in bituminous mining, while falls of persons were responsible for 13 percent of all injuries in anthracite and 12 percent of those in bituminous mining (table 5).

The accident hazard connected with stripping operations which is most similar to falls of roof or coal underground is falls or slides of coal or overburden. This hazard is not particularly important as a cause of all disabling injuries, but it is the most frequent single cause of fatalities both in anthracite and in bituminous open-cut operations. It was responsible for 26 percent of the fatal injuries to workers in anthracite and for 22 percent of the fatalities in bituminous operations of this type. Other important causes of fatal injuries in open-cut operations are power shovels, scrapers or buckets, explosives, and electricity.

TABLE 5.—*Causes of fatal and nonfatal injuries occurring in open-cut operations in coal mines; United States, 1933-37*

Cause of injury	All injuries		Fatal injuries		Nonfatal injuries	
	Number	Percent distribution	Number	Percent distribution	Number	Percent distribution
All coal mines						
All causes.....	7, 208	100. 0	88	100. 0	7, 120	100. 0
Handling materials.....	1, 151	16. 0	-----	-----	1, 151	16. 2
Falls of persons ¹	891	12. 4	6	6. 8	885	12. 4
Hand tools.....	718	10. 0	1	1. 1	717	10. 1
Power shovels, scrapers, or buckets.....	639	8. 9	14	15. 9	625	8. 8
Falling objects, other than coal.....	594	8. 2	5	5. 7	589	8. 3
Falls or slides of coal or overburden.....	437	6. 1	21	23. 9	416	5. 8
Drills.....	302	4. 2	2	2. 3	300	4. 2
Mine cars and locomotives.....	285	3. 9	2	2. 3	283	4. 0
Railway cars and locomotives.....	253	3. 5	5	5. 7	248	3. 5
Stepping on or striking objects.....	253	3. 5	-----	-----	253	3. 5
Electricity.....	154	2. 1	9	10. 2	145	2. 0
Explosives.....	151	2. 1	14	15. 9	137	1. 9
All other.....	1, 380	19. 1	9	10. 2	1, 371	19. 3
Anthracite						
All causes.....	2, 355	100. 0	34	100. 0	2, 321	100. 0
Handling materials.....	361	15. 3	-----	-----	361	15. 5
Falls of persons ¹	306	13. 0	4	11. 8	302	13. 0
Hand tools.....	162	6. 9	-----	-----	162	7. 0
Power shovels, scrapers, or buckets.....	172	7. 3	6	17. 7	166	7. 2
Falling objects, other than coal.....	161	6. 9	1	2. 9	160	6. 9
Falls or slides of coal or overburden.....	90	3. 8	9	26. 4	81	3. 5
Drills.....	175	7. 4	2	5. 9	173	7. 4
Mine cars and locomotives.....	88	3. 7	1	2. 9	87	3. 8
Railway cars and locomotives.....	141	6. 0	2	5. 9	139	6. 0
Stepping on or striking objects.....	92	3. 9	-----	-----	92	4. 0
Electricity.....	42	1. 8	2	5. 9	40	1. 7
Explosives.....	39	1. 7	2	5. 9	37	1. 6
All other.....	526	22. 3	5	14. 7	521	22. 4
Bituminous						
All causes.....	4, 853	100. 0	54	100. 0	4, 799	100. 0
Handling materials.....	790	16. 3	-----	-----	790	16. 5
Falls of persons ¹	585	12. 0	2	3. 7	583	12. 1
Hand tools.....	556	11. 5	1	1. 8	555	11. 6
Power shovels, scrapers, or buckets.....	467	9. 6	8	14. 8	459	9. 6
Falling objects, other than coal.....	433	8. 9	4	7. 4	429	8. 9
Falls or slides of coal or overburden.....	347	7. 2	12	22. 2	335	7. 0
Drills.....	127	2. 6	-----	-----	127	2. 6
Mine cars and locomotives.....	197	4. 1	1	1. 9	196	4. 1
Railway cars and locomotives.....	112	2. 3	3	5. 6	109	2. 3
Stepping on or striking objects.....	161	3. 3	-----	-----	161	3. 3
Electricity.....	112	2. 3	7	13. 0	105	2. 2
Explosives.....	112	2. 3	12	22. 2	100	2. 1
All other.....	854	17. 6	4	7. 4	850	17. 7

¹ Excludes falls from cars.

Source: Compiled from Coal-Mine Accidents in the United States, 1933, 1934, 1935, 1936; and Employment and Accidents at Coal Mines in the United States, 1937. U. S. Bureau of Mines.

Hazards of the various occupations.

As in the case of underground and surface operations, some of the hazards of open-cut mining affect all occupational groups, including the stripping-shovel crews, dragline crews, loading-shovel crews, coal cleaners, and laborers. This is due to the fact that the work by its very nature involves the handling of heavy materials and the use of powerful and complicated machinery. Furthermore, injuries due to falls of persons may be suffered by any person working about the different levels and the rough terrain of a stripping job. The handling of materials, whether coal, rock, or machine parts, involves another type of hazard which affects all occupational groups.

Workers nearest the spoil pile or the high wall, including shovel engineers or operators, firemen, oilers, and groundmen, are the ones most exposed to injury from falls or slides of coal or overburden, one of the causes of many serious accidents. These men also tend to be in greater danger of injury from power shovels, scrapers, or buckets than other workers.

Employees engaged in haulage are the ones chiefly affected by the hazard of injuries due to mine cars and locomotives, railroad cars and locomotives, and trucks. The general use of heavy automobile trucks operating over temporary roads is becoming one of the most serious hazards of stripping operations.

Injuries due to drills and explosives are largely limited to employees working as drillers, drillers' helpers, or shot firers, although the possibility of injury extends beyond the persons actually handling the explosives. Similarly, the use of high voltages for operation of shovels and other equipment has created an electrical hazard that extends beyond the persons actually operating the machines. The danger of accidental contact with electric conductors is one shared by most of the workers.

When all these hazards are considered, it appears that no occupation in open-cut mining operations is removed from the serious dangers of work in the open pits.

Hazards of Surface Operations

Causes of accident.

As is indicated in table 2 (p. 18), the frequency rate of disabling injuries for the surface operations of bituminous mines is considerably lower than the rates for bituminous underground and open-cut operations. It is, however, much higher than the frequency rate for manufacturing as a whole. In the anthracite industry, the rate of injury to surface workers is lower than that for workers employed underground but higher than that for open-pit workers and several times as high as the rate for manufacturing.

Statistics compiled by the Bureau of Mines on the causes of surface accidents indicate that although workers employed in the surface operations about coal mines are spared some of the most serious hazards of underground accidents (especially those of falls of roof, face, or rib) they are exposed to some of the other hazards of underground and open-pit work (such as those of injury in haulage accidents), and are also subject to serious hazards peculiar to the surface operations.

The causes of accident most often responsible for disabling injuries to surface workers are mine cars and mine locomotives, handling materials, and falls of persons. During the 5-year period 1933-37 each of these causes was responsible for 15 to 17 percent of the disabling injuries, fatal and nonfatal, to surface employees in the coal-mining industry as a whole (table 6). The next most frequent causes of injury—machinery on the surface, hand tools, falling objects, and railway cars and locomotives—each accounted for 6 to 9 percent of the disabling injuries reported, taking fatal and nonfatal injuries together.

TABLE 6.—*Causes of fatal and nonfatal injuries occurring in surface operations at coal mines; United States, 1933-37*

Cause of injury	All injuries		Fatal injuries		Nonfatal injuries	
	Number	Percent distribution	Number	Percent distribution	Number	Percent distribution
All coal mines						
All causes.....	28, 724	100. 0	373	100. 0	28, 351	100. 0
Mine cars and mine locomotives.....	4, 982	17. 4	80	21. 5	4, 902	17. 3
Handling materials.....	4, 888	17. 0	11	3. 0	4, 877	17. 2
Falls of persons ¹	4, 313	15. 0	52	13. 9	4, 261	15. 0
Machinery on surface.....	2, 681	9. 3	63	16. 9	2, 618	9. 2
Hand tools.....	2, 678	9. 3	4	1. 1	2, 674	9. 4
Falling objects.....	1, 941	6. 8	21	5. 6	1, 920	6. 8
Railway cars and locomotives.....	1, 816	6. 3	54	14. 5	1, 762	6. 2
Electricity.....	581	2. 0	30	8. 0	551	2. 0
Explosives.....	185	. 7	9	2. 4	176	. 6
All other.....	4, 659	16. 2	49	13. 1	4, 610	16. 3
Anthracite						
All causes.....	12, 671	100. 0	105	100. 0	12, 566	100. 0
Mine cars and mine locomotives.....	2, 065	16. 3	22	21. 0	2, 043	16. 3
Handling materials.....	2, 470	19. 5	3	2. 9	2, 467	19. 6
Falls of persons ¹	1, 812	14. 3	15	14. 3	1, 797	14. 3
Machinery on surface.....	1, 106	8. 7	12	11. 4	1, 094	8. 7
Hand tools.....	1, 431	11. 3	1	. 9	1, 430	11. 4
Falling objects.....	870	6. 9	4	3. 8	866	6. 9
Railway cars and locomotives.....	834	6. 6	19	18. 1	815	6. 5
Electricity.....	253	2. 0	10	9. 5	243	1. 9
Explosives.....	96	. 7	3	2. 9	93	. 7
All other.....	1, 734	13. 7	16	15. 2	1, 718	13. 7
Bituminous						
All causes.....	16, 053	100. 0	268	100. 0	15, 785	100. 0
Mine cars and mine locomotives.....	2, 917	18. 2	55	21. 7	2, 859	18. 1
Handling materials.....	2, 418	15. 1	8	3. 0	2, 410	15. 3
Falls of persons ¹	2, 501	15. 6	37	13. 8	2, 464	15. 6
Machinery on surface.....	1, 575	9. 8	51	19. 0	1, 524	9. 6
Hand tools.....	1, 247	7. 8	3	1. 1	1, 244	7. 9
Falling objects.....	1, 071	6. 7	17	6. 3	1, 054	6. 7
Railway cars and locomotives.....	932	6. 1	35	13. 1	917	6. 0
Electricity.....	328	2. 0	20	7. 5	308	2. 0
Explosives.....	89	. 5	6	2. 2	83	. 5
All other.....	2, 925	18. 2	33	12. 3	2, 892	18. 3

¹ Excludes falls from cars.

Source: Compiled from Coal-Mine Accidents in the United States, 1933, 1934, 1935, 1936; and Employment and Accidents at Coal Mines in the United States, 1937. U. S. Bureau of Mines.

If the fatalities are considered alone, some of these causes of accident assume greater importance. Thus, mine cars and locomotives are distinctly the most frequent cause of fatal injuries, although as a cause of all disabling injuries they are hardly more important than handling materials. Similarly, machinery and railway cars and locomotives are the second and third most frequent causes of fatalities, although they rank fourth and seventh, respectively, among the causes of all disabling injuries.

These figures are for anthracite and bituminous mining combined. If the two industries are considered separately there are only minor differences in the relative ranking of the various causes of accident. The significant and striking contrast between the two industries lies in the fact that disabling injuries due to all causes are more than twice as frequent in anthracite as in bituminous surface operations (table 2). Since the preparation of anthracite is a much more complicated process than that of bituminous coal, involving the use of much more machinery and the handling of much greater quantities of materials, a greater frequency of accidents due to such causes as machinery, handling materials, and falling objects would be expected. Furthermore, the greater height of anthracite breakers than of bituminous tipples and their greater number of intermediate floor levels and platforms probably increase the hazard of falls of persons. The number of haulage accidents is also increased in anthracite mines where the breaker is not located at the shaft by the necessity of re-forming the loaded mine cars into trips for haulage to the breaker, a process which is unnecessary in the many bituminous mines where the cars can be hauled to the tippie in the same trip that brought them to the surface.

Hazards of the various occupations.

The accident hazards involved in surface operations about coal mines have the effect, because of their wide occupational coverage, of creating a generally hazardous working environment throughout most of the area of these operations. All surface employees are exposed to this environment while going to and from their working places; for example, any worker who has occasion to cross the tracks may be injured by mine or railroad cars or locomotives. During working hours, however, some occupational groups face greater hazards than others, and it is therefore important to consider the various jobs from the point of view of the nature and relative importance of their characteristic hazards.

Haulage employees working on the surface face much the same hazards as those employed underground except that they are not exposed to falls of roof or coal or the other general hazards peculiar to underground work, which cause a minority of the injuries to underground haulage employees. Motormen and their helpers working on the surface are also spared the danger of being crushed between a car or locomotive and the roof or rib of the mine passageway; but they are exposed to other haulage hazards, such as derailments or those involved in coupling, uncoupling, or spragging cars, to the same extent as underground motormen and helpers. The occupation of topman exposes the worker to the dangers connected with the handling of cars and work about a shaft and is thus comparable in hazard with the occupation of bottom man, although the exact nature of the shaft

hazards is different in the two occupations, topmen being in danger mainly of falling down the shaft and bottom men of being crushed by the cage or of being hit by falling objects.

No injury rates are available specifically for surface haulage employees nor for any other detailed groups of surface occupations. The accident hazard to surface motormen, to their helpers, and to topmen may be judged, however, from the great frequency of injuries to underground haulage employees, shown on page 28, since the most important haulage hazards affect both underground and surface workers. It is apparent that the dangers of haulage occupations are such as to render them unsuitable for young workers.

The hazards of haulage operations do not extend to the hoisting engineer while he is at his place of work, nor does this occupation involve other marked dangers. Yet, since a hoisting engineer is responsible for the safety of all persons and property hoisted or lowered into or out of the mine, this occupation is generally considered to require mature and experienced employees.

Weighmen and check pullers, who constantly work about mine cars, are exposed to the danger of haulage accidents and consequently are subject to a considerable accident hazard. Tipple men also may face the hazard of accidents due to mine cars and locomotives at mines where the cars are unloaded in the tipple. The most characteristic dangers to tipple employees are, however, those of work about moving machinery and power transmission equipment, including belts, gears, and shafting—dangers which are aggravated in many tipples by inadequate guarding of the machinery. Tipple men are also subject to the hazard of injuries due to falls of persons and falling objects, especially since the tipples are often rough temporary structures with narrow working platforms which may be without adequate guard rails. Another hazard which applies particularly to car droppers and slate pickers who work on railroad cars is that of falling from or being crushed by these cars. Taken together, these various hazards constitute a dangerous working environment for most tipple men. The least hazardous occupation about the tipple is apparently that of slate or other refuse picking at a picking table. So long as workers in this occupation remain in their working places, they do not appear, on the basis of present information, to be in marked danger of injury.

Employees in anthracite breakers are subject to the same general types of hazards as tipple men, except that they are removed from the danger of injuries from mine cars, which are usually dumped outside the breaker. The frequency rate of disabling injuries is, however, undoubtedly higher among breaker than among tipple men. Although breakers are usually better-constructed buildings than tipples, with more effective mechanical guarding, these safety factors do not offset the intensified accident hazard which results from the complicated breaker processes and machinery. All occupational groups within the category of breaker men are to some extent exposed to the hazard of accidents due to machinery, handling materials, hand tools, and other causes. It is probable, however, that slate pickers who work exclusively at a picking table are in less danger of injury than other breaker employees.

Engineers and firemen, who constitute the powerhouse crew, are not exposed to the hazards of haulage or of work about the tipple or breaker, but they do face certain hazards from work about moving

machinery, such as prime movers and generating equipment. They are also exposed to possible injury in a boiler explosion. For these reasons it appears that any work in a powerhouse is unsafe for young and inexperienced workers.

The few clerical workers employed about the mine office, except those whose duties require them to go underground, are apparently quite free from serious accident exposure.¹¹ The various craftsmen in the repair and maintenance shops, such as blacksmiths and their helpers, car repairmen, carpenters, electricians, mechanics, and welders, appear to be in less danger of injury than those surface workers directly concerned with the handling of coal. The types of accidents most likely to affect repair and maintenance men are those due to handling materials and to hand tools. However, these workers are employed in the generally hazardous environment of the mine, and they may work underground for a considerable period of time under trying and dangerous conditions when there is a haulage wreck or when emergency repairs are necessary. Only when they work exclusively in the repair shop may their jobs be considered as relatively safe and comparable in hazard to similar occupations in nonmining industries.

Outside trackmen and clean-up men are employed about haulage operations, with the resultant exposure to injury from cars and locomotives. Trackmen also handle heavy materials and may be injured in accidents due to handling of such materials. The hazards to other unclassified workers who may be employed about certain mines are determined by the nature of their jobs, but these workers are likely to be exposed to a considerable extent to the generally hazardous environment of the surface operations.

Accident Statistics by Age Group

No recent statistical data based on American experience are available showing the number of injuries to coal-mine workers under 18 years of age in relation either to the number of man-hours worked by this age group or to the number of workers under 18 employed. However, industrial-injury rates by age group are given for coal-mine workers in the reports of the Secretary for Mines for Great Britain. No strict comparison is possible between the accident experience in England and in the United States, since British mining methods differ from methods used in this country and younger boys are employed in British than in American mines. Nevertheless, it is believed that the comparative hazards to young workers and to adults in British mines are somewhat indicative of the situation in this country.

The British statistics show the number of workers under 18 years of age killed and injured (that is, disabled for more than 3 days) per 1,000 workers employed underground and on the surface. As table 7 shows, the injury rates for workers under 16 and for those 16 and 17 years of age were considerably higher in 1937 and in 1938 than the rates for older groups. This difference held true for employment both underground and on the surface. To what extent it is

¹¹ The coal-mine accident statistics compiled annually by the U. S. Bureau of Mines, on which are based most of the figures in this report, do not cover accidents to office employees, except where such persons assisted in rescue work after an explosion or other disaster. (Coal-Mine Accidents in the United States: 1936, Bulletin 420, p. 6, Washington, 1939.)

attributable directly to age cannot be determined. The fact that these boys were inexperienced would in itself tend to raise the injury rate, because of the higher susceptibility of new employees to accident, which is generally recognized by safety engineers. But whatever the explanation may be, the British experience definitely indicates that the injury rates for workers under 18 years of age in the coal mines of Great Britain are higher than those for older workers.

TABLE 7.—*Number of workers injured per 1,000 employed at British coal mines, by age group, 1937-38*¹

Age group	1937	1938	Age group	1937	1938
UNDERGROUND WORKERS			SURFACE WORKERS		
All ages.....	206	194	All ages.....	66	64
Under 16 years.....	230	247	Under 16 years.....	105	102
16 and 17 years.....	235	230	16 and 17 years.....	100	94
18 and 19 years.....	193	188	18 and 19 years.....	78	75
20 years and over.....	203	191	20 years and over.....	59	58

¹ Workers fatally injured or disabled for more than 3 days.

Source: Eighteenth Annual Report of the Secretary for Mines for the Year Ended 31st December 1938 and the Thirty-first Annual Report of H. M. Chief Inspector of Mines for the same period, table 59, p. 226 London, 1940.

HEALTH HAZARDS

In addition to the accident hazards of coal-mine employment, many workers, at least in underground operations, are exposed to health hazards. Underground workers are not only deprived of sunshine but are frequently exposed to coal and rock dust, to abnormally high or low humidity, and to gaseous atmosphere. These conditions are known to be detrimental to health and injurious to the growth and development of immature persons, especially if the young workers are exposed to them for many hours daily or over a prolonged period.

Little exact information is available, however, with regard to the prevalence of occupational diseases among coal-mine workers or the specific effects of coal-mine conditions on health and development. Furthermore, the data already presented on accident hazards have adequately indicated the hazardous nature of underground work. For these reasons, no attempt is made in this report to analyze the nature or the gravity of health hazards for young workers in coal mines.

MINIMUM-AGE STANDARDS

The accident hazard to coal-mine workers has long received widespread public recognition in the United States. This recognition led to the prohibition of the employment of children in mines as one of the earliest types of labor regulation in this country and more recently to the enactment in many States of detailed safety codes for mine operation designed to reduce mining hazards. Recognition of the need to protect young people against the hazards of coal-mine work also led, under the N. R. A., to the inclusion in the Code of Fair Competition for the Bituminous Coal Industry of a minimum age higher than that embodied in most other codes.¹ More recently it has been an important factor in the establishment of minimum-age standards for employment in the industry by agreement between the operators and the unions and by the hiring policies of operators.

In the following discussion consideration will be given first to the legal minimum-age standards for coal-mine work and then to the customary standards which have been established by employers and labor unions.

State Laws and Regulations

A legal minimum age for employment in coal mines, which is higher than the basic minimum age for factory and other employment, has been very generally established by State law in this country. Many of the minimum-age provisions refer to work "in or in connection with" or "in or about" coal mines and thus clearly cover surface operations as well as underground work. However, a number of the provisions are limited by their phraseology to employment "in" coal mines and may therefore apply only to underground operations and work in the pit of stripping operations.

Provisions applying to work in coal mines.

The laws of 21 of the 24 coal-producing States set a minimum age for work in coal mines which is higher than the basic standard of the State child-labor law, either through a provision applying to coal mines only or through one applying to any mine. Each of the 3 other States specifies the same minimum age for work in coal mines as for factory and general employment. Among the 21 States with a higher standard for work in coal mines, the minimum age specified is 13 years in 7 States,² 17 years in 1 State (Texas), and 16 in 12 States;³ in the twenty-first State (Iowa) it is 16 years during the school term and 14 years during vacation. These ages are, in most instances, set by the child-labor laws, although in some cases by the mining laws. In

¹ No code was adopted for the anthracite industry.

² Alabama, Indiana, Michigan, New Mexico, Utah, Virginia, and West Virginia. In New Mexico the standard applies only to work underground.

³ Arkansas, Colorado, Illinois, Kansas, Kentucky, Maryland, Missouri, North Dakota, Oklahoma, Tennessee, Washington, Wyoming.

the 3 coal-producing States with a minimum age for work in coal mines which is the same as the basic minimum age for factory and other general employment, the standard set is 16 years.⁴

In addition to these standards, which apply to both sexes and to any work in coal mines regardless of occupation, 14 States have laws prohibiting the employment of women or girls of any age in mines, and a number of States have set special minimum-age qualifications for particular mining occupations. In Pennsylvania, where the general minimum age for work in mines is 16 years, there is a statutory prohibition against the employment of persons under 18 in "dangerous occupations" in mines. In addition, a long list of specific coal-mine occupations have been declared hazardous and therefore subject to an 18-year minimum age by regulation of the State Industrial Board. The occupations not covered by this list, in which 16- and 17-year-old boys may be employed, include that of trapper and also those of loading and pick mining in bituminous mines under the supervision of an experienced miner. In anthracite mines loading and pick mining are subject to an 18-year standard whether or not done under supervision, and in addition there is an 18-year minimum age for running the breaker engine. In Pennsylvania, also, a 21-year minimum age has been set by statute for footmen, topmen, and trip riders in bituminous mines; in Washington there is an 18-year minimum age for the occupations of hooker-on at the bottom of any slope or cager at the bottom of any shaft; in Kansas there is a 25-year minimum age for shot firers and shot inspectors; and in Colorado, a 23-year minimum for shot firers. These minimum-age qualifications have been established for specific nonsupervisory occupations inside coal mines. Minimum ages ranging from 21 to 35 years have also been set in many States for supervisory positions, such as those of mine inspector, mine foreman, or fire boss, which involve heavy responsibility for lives and property, but these requirements do not bear directly on this investigation.

Provisions applying to work about or in connection with coal mines.

In a number of States the minimum age for employment about coal mines is the same as that for work in such mines; in other States it is lower. As has been indicated, 21 of the 24 coal-producing States have a minimum age for work in coal mines which is above the basic minimum age for general employment. Only 13 States have such a minimum age for work about coal mines. The age specified for employment about mines is 18 years in 2 of these States (Alabama, Michigan), 16 years in 10 States,⁵ and in the thirteenth State (Iowa) 16 years during the school term with no minimum age during vacation.

A minimum age which is the same as the basic standard for general employment has been specifically applied to work about coal mines in 3 of the 24 States. Two of these States (Montana and Ohio) have a 16-year standard and the third State (Washington) a 14-year standard. In 7 other States no minimum age has been

⁴ Montana, Ohio, Pennsylvania.

⁵ Colorado, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, North Dakota, Oklahoma, Wyoming. In addition, Arkansas has a 16-year minimum age for work in coal breakers.

specified for work about or in connection with coal mines, but such work is apparently covered by the basic standards for general employment, which are as follows:

16 years-----	Utah
16 years during school hours, 14 years outside school hours-----	Pennsylvania, West Virginia
14 years-----	Arkansas, Virginia ¹
14 years during school term, no minimum age during vacation-----	Tennessee
14 years during school hours, no minimum age outside school hours-----	New Mexico

¹ In West Virginia the 14-year provision applies only to boys on special permit.

In the one other coal-producing State (Texas) no minimum age has been specified for work about coal mines even during school hours, nor does such work appear to be covered by any general minimum-age provision. It should be noted, however, that this State produces little coal and therefore affords small opportunity for the employment of boys about mines.

These provisions have the net effect of establishing a minimum age of 16 years for work about coal mines in 13 States and an 18-year standard in 2 States. In addition, 8 States have laws prohibiting the employment of a girl or woman of any age either about any mine or about coal mines. Furthermore, in 1 State (Arkansas), where the basic 14-year provision of the child-labor law is apparently the only minimum-age standard applying to all types of work about coal mines, there is a 16-year minimum age for employment in coal breakers. In Pennsylvania the general standard for work about coal mines (16 years during school hours and 14 years at other times) is supplemented by a statutory minimum age of 18 years for "dangerous occupations" about mines and by a regulation of the Industrial Board setting an 18-year standard for car handling, repairing or laying tracks, and a number of other specific occupations outside coal mines. (Appendix C, pp. 52, 53.)

There is only one surface occupation—that of hoisting engineer—for which special minimum-age qualifications have frequently been established. In two States (Arkansas, Missouri) no person under 18 and in four States (Illinois, Kansas, Pennsylvania, Washington) no person under 21 may be employed as a hoisting engineer. Although these requirements apply in most instances to all hoisting engineers at coal mines, they are sometimes restricted to those placed in charge of engines whereby persons are lowered or hoisted out of mines. It is plain that the minimum-age qualifications for hoisting engineers have been adopted to prevent the employment of immature persons in a position involving responsibility for the safety of the many persons hoisted or lowered, rather than out of regard for the safety of the engineers themselves.

N. R. A. Code Provisions

Additional legal recognition was given to the hazards of employment inside coal mines and to the consequent need to protect young persons from such employment by the industry codes adopted pursuant to the National Industrial Recovery Act. Although the prevailing minimum age of the N. R. A. codes was 16 years, the Code of

Fair Competition for the Bituminous Coal Industry contained the following provision:

No person under seventeen (17) years of age shall be employed inside any mine or in hazardous occupations outside any mine, provided, however, that where a State law provides a higher minimum age, the State law shall govern; no person under the age of sixteen (16) shall be employed in or about a mine.

No N. R. A. code was adopted for the anthracite industry.

Customary Minimum-Age Standards

Labor-union agreements.

Although the N. R. A. codes were invalidated in 1935, the 17-year minimum-age standard of the bituminous-coal code has survived through embodiment in the Appalachian Agreement of the United Mine Workers of America. This agreement, which is negotiated by the union with a joint conference of coal operators' associations in the Appalachian fields, covers in general the union districts in the Pennsylvania bituminous area and in Maryland, Virginia, West Virginia, Tennessee, eastern Kentucky, Ohio, and Michigan, and to a considerable extent serves as a model for agreements negotiated by the United Mine Workers elsewhere in the country.

The minimum-age provision of the Appalachian Agreement is as follows:

No person under seventeen (17) years of age shall be employed inside any mine nor in hazardous occupations outside any mine; provided, however, that where a state law provides a higher minimum age, the state law shall govern.

This provision is the same as that of the bituminous-coal code, except that it omits the 16-year minimum age for nonhazardous occupations outside mines. In some agreements negotiated outside the Appalachian area (for example, in the agreement between District No. 15 and the Coal Producers of Colorado and New Mexico and in that between District No. 23 and the Western Kentucky Coal Operators' Association) the 16-year clause has been retained and the minimum-age provision reads exactly like that of the bituminous-coal code.

Although 17 years is the prevailing minimum-age standard for work inside mines under the jurisdiction of the United Mine Workers of America, an 18-year standard is provided in some of the union's agreements. In Alabama, where all the agreements negotiated contain provisions setting an 18-year minimum age for work in or about coal mines, these provisions merely reaffirm the 18-year standard already established by State law. In Illinois, however, an 18-year minimum age for work inside mines and for "hazardous occupations" outside mines has been embodied in the agreement between District No. 12 and the Illinois Coal Operators' Association, although the minimum age for such work set by State law is 16 years. In Pennsylvania a few agreements negotiated with individual operators in the bituminous fields as a supplement to the Appalachian Agreement prohibit the employment of anyone under 18 inside mines, though the State law and regulations allow 16- and 17-year-old boys to do some types of work inside mines. By establishing a standard higher than that required by law, these agreements clearly recognize the need to protect 17-year-

old as well as 16-year-old boys against the hazards of employment inside mines.

No minimum-age provision is contained in the Pennsylvania Anthracite Agreement nor in the agreements negotiated by some western districts of the United Mine Workers. In the absence of such a provision, the standard recognized by the union as applicable is that set by State law.

The Progressive Mine Workers of America has a uniform 16-year minimum-age qualification for membership in the union, which is written into the union constitution and which applies both to members working underground and to those in surface occupations. The union takes the position, however, that where the standards set by State laws are higher than 16 years they should be observed in mine employment.

Employment policies.

The minimum-age standards for coal-mine work which have been established by employers as part of their hiring policies vary to some extent in different coal-producing sections of the country. In general, the custom is not to employ boys under 18 years of age especially in underground work.

Many of the larger operators in the Pennsylvania anthracite industry have adopted a policy of hiring no underground workers less than 18 years of age, since under Pennsylvania law and regulations the employment of minors underground in anthracite mines is very much restricted. This policy has been applied, though to a less extent, to outside work about anthracite mines, probably because certain kinds of work in surface operations are prohibited for minors under 18 years of age.

Underground work in bituminous mines appears to be largely restricted to persons 18 years of age or over by the employment policy of the mine operators. This policy is widespread, especially among the larger mines, although there are some exceptions to it. In States where employment underground is permitted under certain conditions for minors under 18 the tendency is not to employ such minors if it can be easily avoided, because of the possibility of unintentional violation of laws or regulations. For example, in Pennsylvania boys between 16 and 18 may do loading and pick mining in bituminous mines only if they are under the supervision of an experienced miner. Employers realize that it is difficult to ensure constant supervision in underground work, and that lack of such supervision may result in unintentional violation of the law.

Many bituminous mines have also adopted the policy of employing no minors under 18 for outside work, or at least for work about the tipples, although this standard is less extensive in the case of surface than of underground work. It is frequently the practice where boys under 18 are employed for mine work to start them in surface jobs and later to transfer them to underground occupations. The number of boys under 18 employed on the surface is undoubtedly larger than the number working underground.

The present situation with respect to minimum-age standards for coal-mine employment is that in many States operators have voluntarily adopted a standard higher than the applicable legal minimum

age. Eighteen years is widely recognized in employment policies of the industry as the minimum age appropriate for underground work and 16, 17, or 18 years as that appropriate for surface work; yet in 16 of the 24 coal-producing States boys may legally work underground at 16 years of age, and in 9 States they apparently may do surface work about mines at 14 years or younger, at least during school vacations. However, most operators in the industry appear not to have taken advantage of these low minimum-age standards for coal-mine employment, either because they recognize the hazards of such work or because there is an abundance of adult labor.

The application of an 18-year minimum-age standard to coal-mine employment, by a determination under the hazardous-occupations clause of the Fair Labor Standards Act of 1938, would therefore be in keeping with the best practices of the industry and would involve a minimum of dislocation to the industry.

Opinions of Experts

The opinions of safety engineers and others interested in the promotion of safe working conditions are of importance in appraising the hazards of coal-mine occupations as they affect young workers. During the course of this investigation, safety engineers, coal-mining engineers, mine inspectors, representatives of labor organizations and trade associations, and others concerned with safety problems in the coal-mining industry were consulted regarding their opinion of the hazards of coal-mine work with reference to an 18-year minimum-age standard.

A commonly expressed opinion was that the hazards of coal-mine work are such that minors under 18 years of age should not be employed in or about coal mines. A few of the persons consulted were of the opinion that all surface work except haulage is reasonably free from hazards and that minors can be safely employed about the tippie or breaker. Others were of the opinion that slate picking and work in the surface repair or maintenance shops are the most logical jobs on which to start new employees provided that at no time is any work done underground. Such work was not considered by these persons to be particularly hazardous for the employment of minors 16 and 17 years of age. One or two persons with whom the matter was discussed felt that it would be satisfactory to permit a 16- or 17-year-old minor to work in the mine provided that he work under the direct supervision of his father or another member of the family. The consensus of opinion with respect to underground work, however, appeared to be that even under the most careful supervision all such work is extremely hazardous.

CONCLUSIONS

1. Work in or about coal mines involves an exceptionally high degree of accident risk, in comparison not only with manufacturing as a whole but also with most other industries for which adequate injury statistics are available.

During the 5-year period 1933-37 the frequency rate of disabling injuries (the number of injuries per 1,000,000 man-hours of employment) was 87.86 for the entire coal-mine industry of the United States. This rate compares with a frequency rate of 17.74 for manufacturing as a whole.

2. In risk of fatal injury, coal-mine work exceeds manufacturing to an even greater degree than it does in the risk of disabling injuries in general.

The frequency rate of fatal injuries for coal mining during the 5 years 1933-37 was 1.63, while the corresponding rate for manufacturing as a whole was only 0.12.

3. The high accident risk in coal-mine work extends to both the anthracite and bituminous industries and involves all types of coal-mine operations—underground, open-cut, and surface work.

The frequency rates of disabling injuries for each of the 3 types of operations in bituminous and in anthracite mining range from 36.82 for the surface operations of bituminous mines to 132.61 for anthracite underground work. The lower of these rates is considerably higher than the corresponding frequency rate for manufacturing as a whole.

The fatality frequency rates for the various types of coal-mine work were in each case several times as high as the rate for manufacturing as a whole. The range in fatality rates for the different coal-mine operations was from 0.61 for the surface operations of bituminous mines to 1.88 for underground work in anthracite mines.

4. All underground occupations, all occupations in open-cut operations, and all surface occupations, with the apparent exception of slate picking and work in offices and in repair and maintenance shops located on the surface, involve exposure to serious accident hazards.

The high rate of injury among underground workers results chiefly from causes of accident that are common in underground work, including falls of roof and coal, the use of haulage equipment and machinery in confined spaces, and explosions. These hazards are difficult to guard against and are so general in their coverage that no underground workers are free from them.

The rough and uneven terrain and other environmental conditions of open-cut operations account for many of the injuries to workers in these operations. All occupational groups are exposed to the hazards arising from these conditions and also to hazards connected with the use of tools and equipment employed in stripping.

The high injury rate among workers in surface operations results in part from general hazards, such as those connected with the haulage of coal on the surface, but it is also due to additional hazards that are characteristic of particular occupations. The occupations apparently involving the least hazard are slate and other refuse picking at picking tables in tipples and breakers, repair and maintenance work in shops located on the surface, and clerical work in mine offices.

5. The accident risk in coal-mine work is probably particularly high for young persons, who are characteristically lacking in the experience and caution needed for work in or about coal mines.

6. State legislation, which reflects public recognition of the particular hazards of coal-mine work for young people, has established higher minimum-age standards for work in or about coal mines than for general employment in the majority of the coal-producing States.

Of the 24 coal-producing States, 21 have set minimum-age standards for work "in" coal mines which are higher than those for general employment while 13 have set such standards for work "about" coal mines.

An 18-year minimum-age standard has been applied to work "in" coal mines in 7 States and to work "about" coal mines in 2 States; elsewhere, the age standard is lower.

7. Employment policies, as developed by operators and through union agreements in the coal-mining industry, frequently recognize a minimum age for coal-mine work that is higher than that established by law.

An 18-year minimum-age standard has been adopted voluntarily by many operators of anthracite and of bituminous mines for underground work and by some operators for surface work.

A 17-year minimum age for all underground work and for hazardous occupations in surface work was set by the N. R. A. code for the bituminous-coal industry and is commonly specified in trade-union agreements in the industry. In some areas an 18-year minimum for such work is provided by trade-union agreement.

8. Many safety engineers, mine inspectors, and other experts consulted have expressed the opinion that, in view of the hazards of coal-mine work, minors under 18 should not be employed at either underground or surface work. Many others who were of the same opinion with regard to underground work believed that certain surface occupations were not particularly hazardous and should be permitted for minors between 16 and 18 years of age.

Appendix A.—Legal Basis for the Investigation

This investigation has been conducted by the Industrial Division of the Children's Bureau pursuant to the regulation entitled "Procedure Governing Determinations of Hazardous Occupations,"¹ issued by the Chief of the Children's Bureau on November 3, 1938, and to the authority conferred by section 3 (1) of the Fair Labor Standards Act of 1938 (Act of June 25, 1938, ch. 676, 52 Stat. 1060, U. S. Code, Supp. IV, title 29, sec. 201), hereafter referred to as the Act. This subsection, which defines "oppressive child labor" as that term is used in the Act, provides in part as follows:

(1) "Oppressive child labor" means a condition of employment under which (1) any employee under the age of sixteen years is employed by an employer . . . in any occupation, or (2) any employee between the ages of sixteen and eighteen years is employed by an employer in any occupation which the Chief of the Children's Bureau in the Department of Labor shall find and by order declare to be particularly hazardous for the employment of children between such ages or detrimental to their health or well-being;

For the purpose of establishing an orderly procedure for determining and declaring occupations to be particularly hazardous for the employment of minors 16 and 17 years of age or detrimental to their health or well-being, the Chief of the Children's Bureau issued the regulation Procedure Governing Determinations of Hazardous Occupations, the first section of which provided in part as follows:

Sec. 421.1. *Investigation and conference.*—Preparatory to the making of a finding by the Chief of the Children's Bureau that an occupation or a group of occupations is particularly hazardous for the employment of minors between 16 and 18 years of age or is detrimental to their health or well-being, a study shall be made of information obtained by the Bureau, or submitted to it with respect to the hazardous or detrimental nature of such occupation or occupations. Conferences may be held with representative employers and workers in the industry, experts in industrial health and safety, and others for the purpose of discussing the nature and characteristics of the occupation or occupations under consideration. A public hearing may be held upon reasonable public notice of the time and place thereof whenever such action is deemed by the Chief of the Bureau to be expedient for the purpose of obtaining such evidence with respect to the nature and characteristics of such occupation or group of occupations. A transcript of the proceedings of any such hearing shall be made and filed with the Bureau. A report of facts and conclusions with respect to the hazardous or detrimental nature of the occupation or occupations under consideration shall be prepared upon the basis of such information and evidence.

In accordance with the provisions of the Act and the regulation referred to, the Chief of the Children's Bureau instructed the Industrial Division of the Bureau to conduct an investigation with respect to the hazardous or detrimental nature of coal-mining occupations, with special reference to young workers, and to consider the problems involved in drafting an order under section 3 (1) of the Act.

¹ Title 29—Labor, Chapter IV—Children's Bureau—Child Labor—Part 421, Procedure Governing Determinations of Hazardous Occupations. The Federal Register, vol. 3, p. 2640 DI, November 5, 1938.

Appendix B.—Supplementary Tables

TABLE I.—Amount of coal produced and number of employees in the coal-mining industry, in specified States, 1937-38¹

State	Production (thousands of net tons)				Number of employees ²		
	1937		1938 (preliminary)		1937		1938 (preliminary) ²
	Number	Percent distribution	Number	Percent distribution	Number	Percent distribution	
United States.....	497,387	-----	390,729	-----	590,949	-----	532,000
Pennsylvania anthracite.....	51,850	-----	46,099	-----	99,085	-----	97,000
Bituminous.....	445,531	100.0	344,630	100.0	491,864	100.0	435,000
Alabama.....	12,440	2.8	10,950	3.2	22,613	4.6	-----
Colorado.....	7,187	1.6	5,676	1.6	9,432	1.9	-----
Illinois.....	51,602	11.6	40,650	11.8	42,449	8.6	-----
Indiana.....	17,765	4.0	14,050	4.1	11,238	2.3	-----
Kentucky.....	47,086	10.6	38,496	11.2	55,596	11.3	-----
Ohio.....	25,178	5.6	17,920	5.2	30,294	6.2	-----
Pennsylvania (bituminous).....	111,002	24.9	77,040	22.3	133,897	27.2	-----
Tennessee.....	5,213	1.2	4,373	1.3	8,465	1.7	-----
Virginia.....	13,795	3.1	12,192	3.5	16,494	3.4	-----
West Virginia.....	118,646	26.6	92,922	27.0	113,643	23.1	-----
Wyoming.....	5,918	1.3	5,200	1.5	4,743	1.0	-----
Other States ⁴	29,699	6.7	25,161	7.3	43,000	8.7	-----

¹ Unauthorized Pennsylvania anthracite mines and also bituminous mines producing less than 1,000 tons per year are excluded from these figures.

² Defined as "the normal working force on the rolls of the mine during periods of active operation."

³ Figures for 1938 were not available by State as of the original date of publication. (See p. 1.)

⁴ Includes States which produced less than 1 percent of the total production of bituminous coal in 1938.

Source: Minerals Yearbook 1939, pp. 770, 772, 778, 779, 833. Bureau of Mines, U. S. Department of the Interior, Washington.

TABLE II.—Number of coal-mine operatives 10 to 17 years of age, in specified States, 1930¹

State	Total		10 to 15 years		16 and 17 years	
	Number	Percent distribution	Number	Percent distribution	Number	Percent distribution
United States.....	15,904	100.0	722	100.0	15,182	100.0
Alabama.....	682	4.3	54	7.5	628	4.1
Colorado.....	184	1.2	16	2.2	168	1.1
Illinois.....	531	3.3	19	2.6	512	3.4
Indiana.....	89	.6	6	.8	83	.6
Kentucky.....	1,768	11.1	128	17.4	1,642	10.8
Ohio.....	677	4.3	12	1.7	665	4.4
Pennsylvania.....	7,842	49.3	280	38.8	7,562	49.8
Tennessee.....	378	2.4	23	3.2	355	2.3
Virginia.....	358	2.2	25	3.5	333	2.2
West Virginia.....	2,497	15.7	98	13.6	2,399	15.8
Wyoming.....	62	.4	2	.3	60	.4
Other States.....	836	5.2	61	8.4	775	5.1

¹ The States specified in this table are those which produced at least 1 percent of the total production of bituminous coal in 1938. (See appendix B, table I.)

Source: Fifteenth Census of the United States, 1930. Population vol. IV, table 23, pp. 128-1796; vol. V, table 10, p. 352. U. S. Bureau of the Census, Washington, 1933.

TABLE III.—Number of man-hours worked and number of fatal and nonfatal injuries occurring at coal mines, by type of mining operation; United States, 1933-37

Type of mining operation	Man-hours worked	Number of injuries		
		All injuries	Fatal	Nonfatal
All coal mines.....	3, 858, 995, 424	339, 036	6, 287	332, 749
Underground.....	3, 162, 411, 439	303, 104	5, 826	297, 278
Open-cut.....	97, 212, 012	¹ 7, 238	88	¹ 7, 150
Surface.....	599, 371, 973	¹ 28, 694	373	¹ 28, 321
Anthracite.....	779, 531, 730	92, 163	1, 232	90, 931
Underground.....	581, 701, 902	77, 137	1, 093	76, 044
Open-cut.....	34, 473, 169	¹ 2, 385	34	¹ 2, 351
Surface.....	163, 356, 659	¹ 12, 641	105	¹ 12, 536
Bituminous.....	3, 079, 463, 694	246, 873	5, 055	241, 818
Underground.....	2, 580, 709, 537	225, 967	4, 733	221, 234
Open-cut.....	62, 738, 843	4, 853	54	4, 799
Surface.....	436, 015, 314	16, 053	268	15, 785

¹ The number of nonfatal injuries in open-cut anthracite mines exceeds by 30 the corresponding figure in table 5, p. 31, while the number of nonfatal injuries shown for anthracite surface operations is 30 less than in table 6, p. 33. The reason for these differences is that the Bureau of Mines classified the 30 dredge injuries which occurred in 1937 with surface operations in the tables showing injuries by cause of accident. Since these 30 injuries were not separable, they had to be left as classified by the Bureau of Mines. However, in the tables showing injuries only by class of mine and extent of disability, the Bureau of Mines classified separately the 30 dredge injuries, and it was therefore possible to include them in the category o, open-cut mining where dredge injuries in other years were classified.

Source: Compiled from Coal-Mine Accidents in the United States, 1933, 1934, 1935, 1936; and Employment and Accidents at Coal Mines in the United States, 1937. U. S. Bureau of Mines.

TABLE IV.—Occupations of workers fatally injured by falls of roof and coal in bituminous mines; Pennsylvania, 1926-30

Occupation	Fatal injuries		Occupation	Fatal injuries	
	Number	Percent distribution		Number	Percent distribution
All occupations.....	1, 052	100. 0	Maintenance.....	105	10. 0
Mining and loading.....	872	82. 9	Trackmen.....	20	1. 9
Pick miners.....	306	29. 1	Roadmen.....	2	. 2
Machine miners.....	492	46. 7	Timbermen.....	52	4. 9
Conveyor loaders.....	3	. 3	Rockmen.....	16	1. 5
Cutting-machine operators.....	63	6. 0	Masons.....	3	. 3
Drillers.....	1	. 1	Brattice men.....	3	. 3
Shot firers.....	7	. 7	Pumpmen.....	3	. 3
Haulage.....	42	4. 0	Electricians.....	5	. 5
Motormen.....	5	. 5	Machinists.....	1	. 1
Drivers.....	25	2. 4	Supervisory.....	17	1. 6
Brakemen.....	9	. 8	Mine foremen.....	2	. 2
Rope riders.....	1	. 1	Assistant mine foremen.....	6	. 5
Signalmen.....	1	. 1	Pillar foremen.....	5	. 5
Trappers.....	1	. 1	Fire bosses.....	4	. 4
			Other.....	16	1. 5
			Laborers not otherwise specified.....	16	1. 5

Source: How and Why Fatalities Occurred in Pennsylvania Bituminous Coal Mines During the Five-Year Period, 1926-30, Information Circular 6505, table 6, p. 10. U. S. Bureau of Mines.

TABLE V-a.—*Causes of fatal injuries occurring underground in coal mines, by occupation of injured worker; West Virginia, 1939*

Occupation	All causes	Falls of roof, face, or rib	Mine cars and locomotives	Explosives	Explosions	Machinery	Electricity	Shaft	All other
All occupations.....	256	173	50	3	6	7	13	2	2
Mining and loading ¹	169	141	10	3	4	6	5		
Miners and their helpers ²	127	109	9	3	2		4		
Cutting- and loading-machine operators and their helpers.....	38	28	1		2	6	1		
Drillers and shot firers.....	4	4							
Haulage.....	48	8	35				3	1	1
Motormen.....	17	1	14				1		1
Drivers.....	4	3					1		
Motormen's and drivers' helpers.....	26	4	21				1		
Bottom men.....	1							1	
Maintenance.....	30	18	3		1	1	5	1	1
Trackmen.....	10	6	1				3		
Timbermen.....	12	8			1	1	1		1
Rockmen.....	5	3	1				1		
Brattice men.....	1		1						
Electricians.....	1	1							
Machinists.....	1							1	
Foremen and assistant foremen.....	7	6	1						
Laborers not otherwise specified.....	2		1		1				

¹ Includes miners, loaders, machine operators, and shot firers.² Includes miners, hand loaders, conveyor loaders.TABLE V-b.—*Causes of fatal injuries occurring on the surface at coal mines, by occupation of injured worker; West Virginia, 1939*

Occupation	All causes	Mine cars and locomotives	Railroad cars and locomotives	Electricity	Machinery	All other
All occupations.....	10	3	3	1	1	2
Car cleaner.....	2		2			
Car trimmer.....	1					1
Car dropper.....	1		1			
Laborer (coupling cars).....	2	2				
Tipple laborer.....	1	1				
Blacksmith.....	1				1	
Electrician.....	1			1		
Assistant foreman.....	1					1

Source: Compiled from Monthly Reports, Coal Mining Section, West Virginia Department of Mines, 1939.

TABLE VI.—*Occupations of workers fatally injured by underground-haulage accidents in bituminous mines; Pennsylvania, 1926-30*

Occupation	Fatal injuries		Occupation	Fatal injuries	
	Number	Percent distribution		Number	Percent distribution
All occupations.....	307	100.0	Maintenance.....	25	9.1
Mining and loading.....	134	43.7	Trackmen.....	8	2.6
Pick miners.....	33	10.7	Timbermen.....	5	1.6
Machine miners.....	91	29.7	Electricians.....	4	1.3
Cutting-machine operators.....	4	1.3	Machinists.....	5	1.6
Cutting-machine operators' helpers.....	4	1.3	Other maintenance employees.....	6	2.0
Drillers.....	2	.7	Other.....	12	3.9
Haulage.....	133	43.3	Mine foremen and fire bosses.....	8	2.6
Motormen.....	37	12.1	Laborers not otherwise specified.....	4	1.3
Drivers.....	33	10.7			
Motormen's and drivers' helpers.....	63	20.5			

Source: How and Why Fatalities Occurred in Pennsylvania Bituminous Coal Mines During the Five-Year Period 1926-30, Information Circular 6505, table 9, p. 19. U. S. Bureau of Mines.

Appendix C.—Legal Minimum-Age Standards for Specific Coal-Mine Occupations ¹

<i>Provisions</i>	<i>State</i>	<i>Minimum age</i>
Employment in any coal mine: ²		
As hoisting engineer-----	Illinois, Kansas-----	21
As hoisting engineer in charge of any engine whereby men are lowered into or hoisted out of mines. ³	Arkansas, Missouri-- Washington-----	18 21
As hooker-on at the bottom of any slope or cager at the bottom of any shaft.	Washington-----	18
As shot firer-----	Colorado-----	⁴ 23
As shot firer or shot inspector-----	Kansas-----	25
In the following occupations inside coal mines:	Pennsylvania-----	⁴ 18
(a) Car handling, which includes blocking, coupling, and uncoupling, driving mules, dropping cars, greasing cars, moving cars by room hoist, pushing or moving cars by hand (except in the working rooms of bituminous mines under the supervision of an experienced miner), retracking cars (except in the working rooms of bituminous mines under the supervision of an experienced miner), rope riding, running cars, spragging cars, and work as brakeman, footman, motorman, or snapper.		
(b) Cleaning tracks.		
(c) Handling explosives.		
(d) Loading, except in bituminous mines under supervision of an experienced miner.		
(e) Oiling machinery.		
(f) Operating or tending cutting machines.		
(g) Operating or tending other mechanical mining devices.		
(h) Pick mining, except in solid work in bituminous mines under the supervision of an experienced miner.		
(i) Repairing or laying tracks.		
(j) Roping pulleys or drums.		
(k) Timbering, except in the working rooms of bituminous mines under the supervision of an experienced miner.		
(l) Work as brattice man, electrician, or electrician's helper, fire boss, pipe-man, pumpman, or rockman.		

¹ Includes standards set by statute or regulations in the 24 coal-producing States. Of these, 17 have no legal minimum-age standards for specific occupations in or about mines. Minimum-age requirements for mine managers, foremen, assistant foremen, inspectors, examiners, fire bosses, or gasmen have not been included here. A minimum-age of 21 years to 30 years is frequently set for these supervisory occupations, but this is explained by the high degree of responsibility for the public safety involved in these occupations rather than by the risk to the employees themselves.

² These provisions apply in some instances only to coal mines and in others to any mine.

³ Laws vary slightly in phraseology.

⁴ Standard set by regulation.

<i>Provisions</i>	<i>State</i>	<i>Minimum age</i>
Employment in any coal mine—Continued.		
In the following occupations outside coal mines:	Pennsylvania.....	⁴ 18
(a) Car handling of the following types:		
Coupling and uncoupling cars, greasing cars, pushing and moving cars by hand, retracking cars, rope riding, spragging cars, and work as brakeman, motorman, or topman.		
(b) Cleaning tracks.		
(c) Oiling machinery.		
(d) Repairing or laying tracks.		
(e) Rock dumping or loading.		
(f) Roping pulleys or drums.		
(g) Standing on shaker screens.		
(h) Work as engineer or fireman.		
(i) Work at loader boom.		
Employment in anthracite mines only:		
Running the breaker engine.....	Pennsylvania.....	18
As engineer placed in charge of engine whereby persons are hoisted or lowered.	Pennsylvania.....	21
Employment in bituminous mines only:		
As furnaceman, hooker-on at the bottom of any slope, or cager at the bottom of any shaft.	Pennsylvania.....	18
As footman, topman, or trip rider.....	Pennsylvania.....	21
As [hoisting] engineer.....	Pennsylvania.....	21

⁴ Standard set by regulation.

Appendix D.—Hazardous-Occupations Order No. 3

AUGUST 1, 1940

Occupations Particularly Hazardous for the Employment of Minors Between 16 and 18 Years of Age or Detrimental to Their Health or Well-Being

SEC. 422.3. *Coal-mine occupations*—(a) *Finding of fact*.—By virtue of and pursuant to the authority conferred by section (3) (1) of the Fair Labor Standards Act of 1938¹ and pursuant to the regulation prescribing the "Procedure Governing Determinations of Hazardous Occupations";² an investigation having been conducted with respect to the hazards for minors between 16 and 18 years of age in employment in coal-mine occupations; a report of the investigation having been submitted to the Chief of the Children's Bureau showing that—

1. Work in or about coal mines involves an exceptionally high degree of accident risk, in comparison not only with manufacturing as a whole but also with most other industries for which adequate injury statistics are available.

2. In risk of fatal injury, coal-mine work exceeds manufacturing to an even greater degree than it does in the risk of disabling injuries in general.

3. The high accident risk in coal-mine work extends to both the anthracite and bituminous industries and involves all types of coal-mine operations—underground, open-cut, and surface work.

4. All underground occupations, all occupations in open-cut operations, and all surface occupations, with the apparent exception of slate picking and work in offices and in repair and maintenance shops located on the surface, involve exposure to serious accident hazards.

5. The accident risk in coal-mine work is probably particularly high for young persons, who are characteristically lacking in the experience and caution needed for work in or about coal mines.

6. State legislation, which reflects public recognition of the particular hazards of coal-mine work for young people, has established higher minimum-age standards for work in or about coal mines than for general employment in the majority of the coal-producing States.

7. Employment policies, as developed by operators and through union agreements in the coal-mining industry, frequently recognize a minimum age for coal-mine work that is higher than that established by law.

8. Many safety engineers, mine inspectors, and other experts consulted have expressed the opinion that, in view of the hazards of coal-mine work, minors under 18 should not be employed at either underground or surface work. Many others who were of the same opinion with regard to underground work believed that certain surface occupations were not particularly hazardous and should be permitted for minors between 16 and 18 years of age;

a finding and order relating to the employment of minors between 16 and 18 years of age in the said occupations having been proposed for final adoption by the Chief of the Children's Bureau upon the basis of the said report of investigation; a public hearing having been held with respect to the said proposed finding and order; all statements sub-

¹ Act of June 25, 1938, ch. 676, 52 Stat. 1060, U. S. Code, Supp. IV, title 29, sec. 201.

² Issued November 3, 1938, pursuant to authority conferred by sec. 3 (1) of the Fair Labor Standards Act of 1938, published in the Federal Register, vol. 3, p. 2640 DI, November 5, 1938.

mitted in connection with the said hearing having been carefully considered and a change having been made in the proposed finding and order in accordance with suggestions made at the hearing; opportunity having been given to all interested parties to file objections within 15 days following publication in the Federal Register³ of the proposed finding and order, as revised, and no objection disclosing just cause for further revision thereof having been received; and sufficient reason appearing therefor,

Now therefore, I, Katharine F. Lenroot, Chief of the Children's Bureau of the United States Department of Labor, hereby find that all occupations in or about any coal mine, except the occupation of slate or other refuse picking at a picking table or picking chute in a tippie or breaker and occupations requiring the performance of duties solely in offices or in repair or maintenance shops located in the surface part of any coal-mining plant, are particularly hazardous for the employment of minors between 16 and 18 years of age.

(b) *Order.*—Accordingly, I hereby declare that all occupations in or about any coal-mine, except the occupation of slate or other refuse picking at a picking table or picking chute in a tippie or breaker and occupations requiring the performance of duties solely in offices or in repair or maintenance shops located in the surface part of any coal-mining plant, are particularly hazardous for the employment of minors between 16 and 18 years of age.

Definitions.—For the purpose of this order—

(1) The term "coal" shall mean any rank of coal, including lignite, bituminous, and anthracite coals.

(2) The term "all occupations in or about any coal mine" shall mean all types of work performed in any underground working, open-pit, or surface part of any coal-mining plant that contribute to the extraction, grading, cleaning, or other handling of coal.

This order shall not justify noncompliance with any Federal or State law or municipal ordinance establishing a higher standard than the standard established herein. This order shall become effective on September 1, 1940, and shall be in force and effect until amended or repealed by order hereafter made and published by the Chief of the Children's Bureau.

KATHARINE F. LENROOT,
Chief of the Children's Bureau.

³ The Federal Register, vol. 5, p. 2580 DI, July 16, 1940.



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